Municipal and County Engineering

DESIGN, CONSTRUCTION, OPERATION AND MAINTENANCE OF ALL PUBLIC WORKS

Vol. LX MAY, 1921 No. 5

CONTENTS

MOTOR TRUCK SECTION

Should Road Contractors Buy or Hire Motor Trucks? 12
Highway Transport Clearing Houses 20

EDITORIALS 175, 176

LEADING ARTICLES

Width of Roadways and Sidewalks in Municipalities 177
Practical Limitations in "Surface Treatment" of Old Brick or Block Pavements .. 181
Some Problems in Concrete Construction 182
Specific Duties of the Highway Engineer and Contractor 187
Solving the Highway Bridge Problem in New Jersey 190
Features of Annual Asphalt Convention 194

WATER WORKS SECTION

Capacity Characteristics of a Deep Well 195
New Reinforced Concrete Covered Reservoir for Arkansas City, Kansas 198
Features of Additional Water Works for St. Louis, Mo. 200
Perkins Coal Handling Machinery in Two Illinois State Power Plants 204
The Economy of Feed Water Heating and Purifying in the Water Works Pumping Station 205
Conditions Governing Installation of Municipally Owned Power and Lighting Plants 208
Operating Data on Wurl Screen and Imhoff Tanks in Plainfield (N. J.) Joint Sewage Works 212

CONSTRUCTION NEWS AND EQUIPMENT SECTION

The Care of Concrete Mixers 23
Performance of Tractor and Wheel Scraper Outfits on Dixon-Henderson Road, Webster County, Ky. 24
Profitable Adaptations of an Excavator and Loader in Pits and Quarries 28
Relaying Granite Block Pavement on Asphalt Macadam Base at Providence, R. I. 32
"Le Clair" Scraper Added to Sauerman Bros. Line 33

Price: Single copy 25 cents. Annual subscription in U. S. $2.00; Canada, $2.40; Foreign, $2.75.

MUNICIPAL AND COUNTY ENGINEERING is published monthly by Engineering Publishing Company, 702 Wulsin Building, INDIANAPOLIS, INDIANA, A. P. Fox, President, J. H. Pritchard, Secretary.

Changes of address, subscriptions and remittances should be addressed to MUNICIPAL AND COUNTY ENGINEERING, Indianapolis, Indiana. Editorial and business communications should also be addressed to 702 Wulsin Bldg., Indianapolis, Ind.

Editorial and Advertising Offices also at 702 Wulsin Bldg., Indianapolis, Ind. Samuel C. Hadden, Editor and General Manager.

Reinforcing Steel Saves Expense on Concrete Roads

Truscon Road Mesh

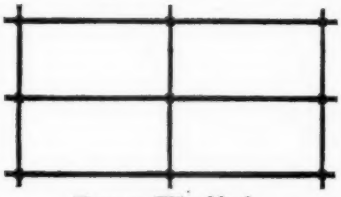
Reinforcing steel increases strength and reduces maintenance.

Truscon Products insure the right reinforcement for concrete roads.

Truscon Road Mesh is an expanded metal with 6x12-inch diamond mesh—furnished in flat sheets 5 feet wide and various lengths.

TRUSCON STEEL CO
TRUSCON
BUILDING PRODUCTS

Truscon Contraction Joint



Truscon Wire Mesh

Truscon Wire Mesh is furnished either in rolls or in large flat sheets, easily handled and placed.

The use of Truscon Contraction Joint completes and perfects the construction. Write for literature and estimates.

Truscon Steel Co.

YOUNGSTOWN, OHIO

Warehouses and Representatives in Principal Cities.

MAY IS GRADING TIME

WORK YOUR ROADS NOW

Austin Ripsnorter

Western No. 20 Grader

Right now is the time to do your grading and resurfacing; now after the heavy April rains.

Roads the country over need working—summer traffic will be heavy.

There is a right way and a wrong way to do such jobs; one the costly way to grade—the other Economy itself.

The first step is to select the proper machine. It is poor economy to try to make one grader do all of the work of three or four different sizes.

The Austin-Western Road Machinery Company are specialists on grading; have made an extensive study for years of conditions that must be faced and the methods best suited to meet them.

Our line is so complete that we never need urge you to pick a grader unsuited to your job. Don't try to change the job to suit your machine. **It costs too much.** You can get a machine exactly suited to your needs.

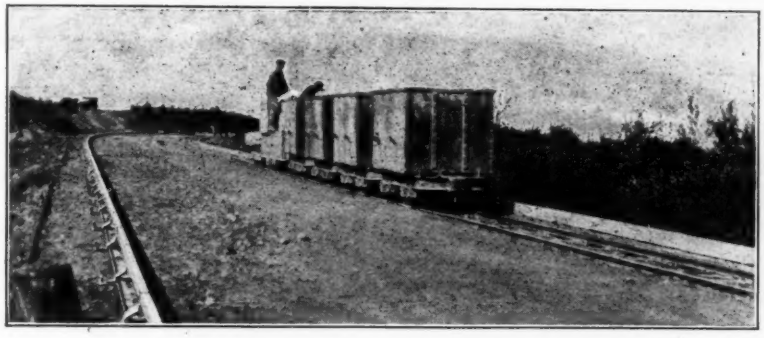
Come to any of the branches listed below for valuable information and advice on grading problems, or write for complete literature.

The Austin-Western Road Machinery Co.

CHICAGO, ILLINOIS

Albany	Chicago	Jackson	New Orleans	Pittsburgh	Salt Lake City
Atlanta	Columbus	Kansas City	New York City	Portland	San Francisco
Billings	Dallas	Los Angeles	Oklahoma City	Richmond	Topeka
Boston	Denver	Nashville	Philadelphia	St. Paul	Wahoo

EXPORT DEPARTMENT
ALMACOA ALLIED MACHINERY COMPANY OF AMERICA ALMACOA



"Built like a Railroad"

"*Facts*, not sales arguments, prove an article worthy of your consideration."

For example—it's a *fact*

Heltzel Steel Road Forms

can be set and stripped quicker than any other form.

It is also a *fact* that by using Heltzel Forms you are assured of a minimum repair bill at the end of the season, because they're

"Built like a Railroad"

Have you a copy of the Heltzel Blue Book?

The Heltzel Steel Form & Iron Co.
WARREN, OHIO

MIDWEST
UTILITOR
Road Maintainer

Get the Facts About this Practical Machine

Keep the streets in and around your town passable and popular at small expense.

No road is too bad—or even too good—to be helped by dragging with the UTILITOR Road Maintainer. This machine is designed to give the maximum results at minimum cost. It turns in a ten foot radius.

A bad spot can be reworked without loss of time. Big drags must cover unnecessary ground in reworking bad spots.

The UTILITOR outfit is not new. The motive unit has been working successfully for over two years. Our engineers have worked out a correct riding hitch for the drag unit.

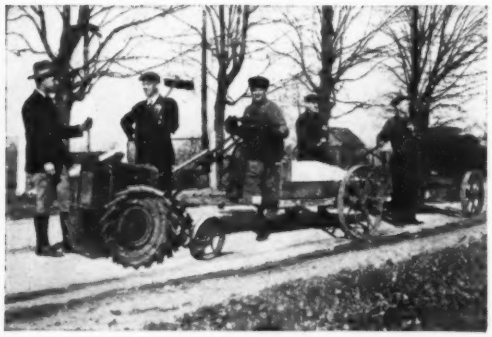
The machine is amply powered and controlled by automatic governor.

Because the work of this machine can be concentrated on the surface actually needing repair, it will drag into condition in one day a total mileage greater than can be done with three horses, and sometimes four.

A big, strong, growing manufacturing institution is behind this machine to guarantee its performance and service.

Our new folder on the UTILITOR Road Maintainer tells the whole story in pictures. Write today. PROMPT DELIVERIES.

MIDWEST ENGINE COMPANY
12 Martindale Ave. INDIANAPOLIS, U. S. A.



FREE

Information, Specifications, Literature and Expert Engineering Advice About

GRANITE

for

PAVING AND CURBING

The Granite Paving Block Mfrs. Association of the U. S., Inc.

31 State St. BOSTON, MASS.

Representing

THE WORLD'S GREATEST GRANITE QUARRIES

PIONEER Highest Quality ASPHALTS

"PIONEER"

Highest Quality Asphalts

Any Melting Point, Any Ductility, Any Penetration

We are Asphalt Specialists, and there is now a PIONEER product complying with practically every Asphalt or Bituminous specification. Let us quote you on your requirements.

OUR POLICY: "A personal interest in every order; an earnest endeavor to please."

"PIONEER"

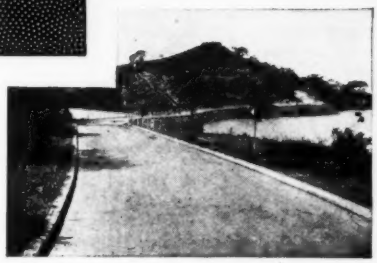
Ruberoad Cement

It's New It's Different It's Efficient

A product that will interest every engineer and contractor; especially made and adapted for repairing cracks in concrete roads and pavements.

THE PIONEER ASPHALT CO.
LAWRENCEVILLE, ILL.

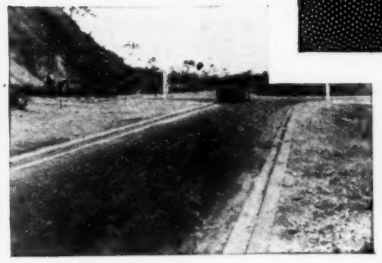
PANAMA AND TEXACO



TEXACO Sheet Asphalt built by the United States Government on the Ancon-Pedro Miguel Highway in the Panama Canal Zone.

For centuries to come posterity will marvel at that master stroke of American engineering represented in the Panama Canal.

It stands as a lasting monument to the skill of our engineers, for it is among the highest accomplishments in the world's engineering construction.



Diablo Road, main highway from Balboa to Diablo, Panama Canal Zone, built of TEXACO Sheet Asphalt, over cement concrete base.

The materials used in building the great Canal were the best to be had.

Just as the great locks and cuts are the last word in scientific construction, so also are the asphalt highways that link the main towns of the Canal Zone the last word in modern road building.

The Texas Company

Asphalt Sales Dept., 17 Battery Place, New York City

New York Houston Richmond Philadelphia Jacksonville Boston New Orleans Tampa Chicago Memphis Oklahoma City Cleveland Minneapolis Kansas City Wichita Des Moines

LITTLEFORD

TAR AND ASPHALT HEATERS

STYLE No. 69

Do You Know?

Do you know that Littleford Tar and Asphalt Heaters have behind them a record of long continuous, satisfactory service in the hands of hundreds of users?

The dependable service has been made possible by the sturdy construction of heavy plate steel material. In Littleford Heaters experience, experiment and constant study have fixed facts and figures, making possible the definite "Safety Factor" which is today built in all Littleford Equipment.

Let Us Send Complete Information. Write now—a post card will do.

LITTLEFORD BROS.

460 E. Pearl Street CINCINNATI, OHIO

Manufacturers of

Asphalt Tampers and Smoothers, Asphalt Rakes, Asphalt Shovels, Pouring Pots, Fire Wagons, Gravel Driers, Mastic Heaters, Roofer's Kettles, Tool Heaters.

Also the

Andresen Road Repair Outfit

ASK ABOUT IT.

Concrete Roads must be reinforced

It is demonstrated beyond doubt that to make concrete roads proof against heavy motor traffic, weather and time a fabric of steel must be incorporated in the concrete.

Several great States have so ruled.

American Steel and Wire Company's Concrete Reinforcement

Fulfills every engineering requirement.

Send for our book on road building.

CHICAGO
NEW YORK
CLEVELAND
PITTSBURGH
DENVER

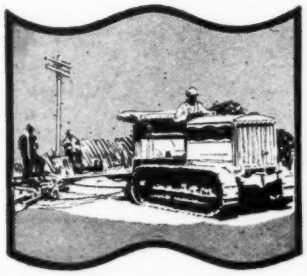
SPRINGFIELD PAVING BRICK

ARE WIDELY USED

Springfield Paving Brick Company

SPRINGFIELD, ILLINOIS.

CATERPILLAR



It Has No Rival for Road Work

A Holt "Caterpillar"* Tractor is the best investment a city, township, county, or a road contractor can make. It will quickly pay for itself in the savings it effects over old methods of moving dirt, pulling graders, wheel scrapers, and scarifiers. With its tremendous power and sure traction the "Caterpillar"* will work on steepest grades or in loose fills and keep going in any weather. Ask for cost figures from actual road jobs, or let us arrange to exhibit moving pictures which show the "Caterpillar"* doing for others what it can do for you. Write or wire for information.

**There is but one "CATERPILLAR"—Holt builds it*

THE HOLT MFG. COMPANY, *Inc.*
PEORIA, ILLINOIS
Eastern Division: 50 Church St., New York

CATERPILLAR
Reg. U.S. Pat. Off.
HOLT
PEORIA, ILL.
STOCKTON, CALIF.

Branches and service stations all over the world

CATERPILLAR

From the Contractor's View Point.

Modern traffic demands a hard surface for the main highways. The contractor, wishing to lay the more common hard types, has been forced to make a heavy investment for equipment; to reckon with a serious depreciation, and to assume the risk of failure due to faulty mixing or workmanship.

Kentucky Rock Asphalt has eliminated all this added cost and hazard.

Kentucky Rock Asphalt is ready mixed by Nature—a perfect mix with each particle of the aggregate 100 per cent coated with pure bitumen.

The material is shipped in open top cars, ready to lay *cold*. It may be stored in the open along the work, without injury from the elements.

Kentucky Rock Asphalt may be placed on any good base, without any binder course or seal coat. Old gravel and macadam roads are being surfaced most successfully. Worn out brick or concrete streets make an ideal base.

No equipment, other than shovels, rakes and roller, is required. No asphalt experts or other skilled labor is needed. Ordinary workmen under competent and careful supervision can build a perfect Kentucky Rock Asphalt road.

Kentucky Rock Asphalt requires no curb or header. It gives a smooth surface equal in every respect to a perfect sheet asphalt and superior in many ways to the best hot mixed types. Kentucky Rock Asphalt does not crack, roll, buckle or bleed. It is absolutely uniform in bitumen, each ton being laboratory-tested before being shipped.

Kentucky Rock Asphalt is the most attractive road surface from both the road builder's and the public viewpoints.

Write for our Booklet E.

Kentucky Rock Asphalt Co.
Incorporated
711-718 Marion E. Taylor Bldg. LOUISVILLE, KY.

Ky. Rock Asphalt

"BEREA"
Sandstone Curbing
Pioneer in the field
PRODUCED BY
The Cleveland Stone Co.
Main Offices:
Union Bldg., 1836 Euclid Ave. CLEVELAND, OHIO
Western Offices:
Room 1112 Merchants Loan & Trust Bldg., Chicago

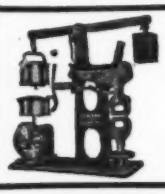
WM. E. DEE COMPANY
30 North LaSalle St. CHICAGO, ILL.

WE MANUFACTURE
D & D Safety Cover
Guaranteed not to Rattle or Dish.
Full Line of MANHOLE and CATCH BASIN COVERS of all kinds.
Patent Numbers—985163-1177850
WRITE FOR OUR PRICES

ACME
Manholes, Catch Basins, Inlet Basins, Park Basins (All Styles)
Regular and Special Grates or Strainers for Sewer Pipe

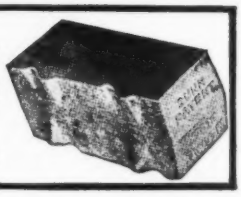
Building Columns of All Descriptions
Send Us Your Specifications
MADISON FOUNDRY CO.
927 Addison Road, CLEVELAND, OHIO.

Advantages-
of WOOD BLOCK PAVEMENTS
Extended for Years With
REILLY'S IMPROVED PERMANENT CREOSOTE OIL
No Bleeding *No Bulging*
Republic Creosoting Company, Indianapolis, Ind.
Plants: Indianapolis Minneapolis Mobile Seattle Norfolk


New Automatic Cement Tester
Grand Prize Panama-Pacific International Exposition, 1915.
Manufacturers of Cement, Concrete, Brick and Road Material Testing Machines and All Auxiliary Laboratory Apparatus
TINIUS OLSEN TESTING MACHINE CO. 500 North Twelfth St. PHILADELPHIA, PA.

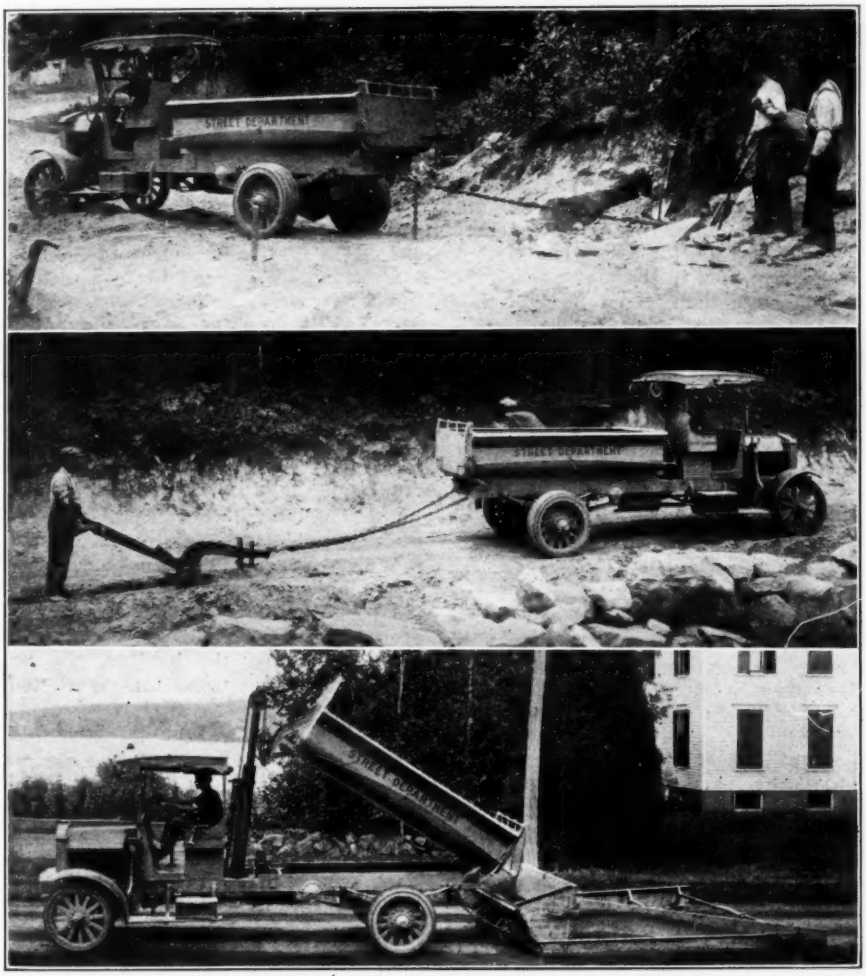
SEWER PIPE — FIRE BRICK
Flue Linings — Wall Coping — Steam Line Conduit — Sewage Disposal Tanks — Fire Clay Meter Boxes
IN STRAIGHT OR MIXED CARS. Manufactured of OHIO RIVER FIRE CLAY.
CANNELTON SEWER PIPE CO., Cannelton, Ind.

MURPHYSBORO PAVING BRICK COMPANY
Equal to the Best
"EGYPTIAN" BLOCK
Surpassed by None
MURPHYSBORO, ILLS.
PROMPT DELIVERIES. LET US QUOTE YOU PRICES.

If you want a sure, durable and reliable road surface, buy
MEDAL BLOCK
The Block with experience behind it
Oldest in Service
Unexcelled in Quality
Medal Paving Brick Company
CLEVELAND, OHIO.


UVALDE
ASPHALT PAVING COMPANY
1 BROADWAY NEW YORK

MOTOR TRUCKS



FEDERAL 3½-TON TRUCK OPERATED BY STREET DEPARTMENT, CITY OF LACONIA, N. H., REMOVING BOULDER, PULLING PLOW, PULLING BURCH STONE SPREADER, ETC.

Motor Truck Operation and Accounting LXIX

SHOULD ROAD CONTRACTORS BUY OR HIRE MOTOR TRUCKS?

Recently in conversation with some men in the motor truck industry it was suggested to the editor that it is much better for the road contractor to own the motor trucks he needs on his work than it is to sublet the hauling work to a hauling contractor equipped with trucks.

These men made a good argument in support of their belief, pointing out that inasmuch as the trucks really set the pace for the contractor's entire crew, and his other equipment, that he should have that complete control of them which can be secured only by ownership. They raised other points of like import and feeling that this is an interesting and important topic for discussion the editor has invited several active men in the motor truck industry to state their views on this subject.

At the outset it may be well to state that the editor does not wish to mobilize all the opinion favoring the ownership of trucks by contractors while denying a hearing to those who, in general, would advise the road contractor to sublet his hauling on road construction work. It is the opinion of the editor that there are some jobs on which the road contractor should own trucks and others on which he might do well to rent them. This seems a reasonable opinion but the reader will naturally ask: "Where will you draw the line? When should the road contractor own and when should he rent trucks?" In other words there are certain limiting conditions within which ownership is preferable and outside of which renting is preferable. It is our opinion that this discussion, in which we invite all interested men to join, will help the individual road contractor decide whether or not, in view of his resources and the extent and nature of the work on which he is engaged, he should buy or hire trucks. If this end is realized the discussion will serve the best interests of all parties and that, of course, is its purpose.

The Discussion

Wm. C. Greany of the Transportation Engineering Department of the Packard Motor Car Co., expresses very concisely the opinion above suggested by the editor. He writes: "In our opinion it would be inadvisable to make any blanket statement covering this subject. It has been our experience that the merits of each particular case must be fully considered in order to determine whether owned or rented equipment would be the most profitable in any specific situation."

A valued correspondent writes as follows in a letter preliminary to a more extended discussion by him of this subject: "It appears to us that there would be every advantage to a contractor owning his own equipment, as do the fleet owners in the United States, of which there are over 12,000 who are owners and users of five or more trucks. This arrangement would get the contractor in line for much better prices on trucks and parts, as it does the fleet owner at the present time for buying trucks direct from the largest motor truck manufacturers at a considerable discount from the list prices."

Mr. A. W. Stromberg of the Acme Motor Truck Co., Cadillac, Mich., writes as follows:

"It would seem that where road contractors sub-let the hauling on construction jobs they are losing out on the possible chance for greater income provided the road building contract covers a big enough project. If the owners of trucks make money on the hauling, the road contractor should make that much more if he owned the trucks, instead of subletting the jobs.

"The size of the road building contract, of course, largely determines the question of whether or not it is more profitable to buy the trucks or to sub-let the hauling. Even on a rather limited contract, it sometimes turns out to be more profitable for the road builder to own his own trucks. We have in mind a special case at Midland, Michigan, where a firm by the name of McKimmy and Yager with a 2-ton Acme dump job in 30 days work on the project practically paid for the

Your business *is* different. Federal gives you the exact truck it demands

Special body styles are developed, correct capacities are recommended

Federal is the right truck, we see that you get the right Federal

Sentenced to labor on the road gang for life—with capacity loads of brick and shell, sand and gravel, cement and slag—this 2 to 2½-ton Federal of the Southern Clay Manufacturing Company of Chattanooga, Tenn., cost but $9.06 for repairs from December, 1916, to January, 1919. This illustrates Federal Truck effieiency under the heaviest kind of load strains.

FEDERAL MOTOR TRUCK CO.
35 FEDERAL AVE. DETROIT, MICH.

Another FEDERAL
One to Seven Ton Capacities

truck itself. On a larger contract it should work out that much better. The contractor by having his own trucks would be able to systematize loading and unloading methods, and work out efficiency plans to even greater advantage than the hauling contractor who usually must conform to the wishes of the road builder.

"It requires a thorough analysis in each case to determine which is the better proposition. Frequently it will pay a road contractor where loading and unloading conditions are most favorable to purchase his own trucks, and if he has no use for them after the job is completed he can dispose of them and still be further ahead of the game than if he had sub-let the hauling. A great many contractors who have been doing this are finding that it frequently pays them to carry the trucks over to the next road building season. During the slack season if they are equipped with combination stake and dump body they can be used in general hauling and a substantial revenue can be derived in this way.

"The tendency seems to be more and more for the road contractor to take on trucks of his own, and we believe that it is conditions such as mentioned above which are bringing him to handle road projects in this way. The conditions in each case are usually so different that a separate analysis must be made and a decision arrived at on this basis."

Mr. Frank B. Willis, Sales Manager of the Duplex Truck Co. of Lansing, Mich., has submitted the following discussion:

"In the first place, the motor truck has proven an absolute necessity for road building work. This is due to the fact that in most cases it is necessary to haul every yard of material which is used in making up the road construction and there is no other way of hauling than by motor truck. As a general thing the road contractor is not the type of business man who pays close attention to details. For this reason there is perhaps not one out of fifty who keep any accurate record of performance of trucks in road building work. They have been led to make their bids for road building jobs based more on their past experience of general costs than on their own knowledge of the actual costs of the particular job on which they are bidding.

"We have noticed cases where road builders have taken contracts for construction work at a price lower than the actual costs of hauling the gravel to the point of work. There was no reason for this other than a lack of attention to details and of knowing the cost of operation. Because of the keen competition in road building, contractors have found themselves losing money in their truck operations and unfortunately have persisted in the idea that they should hire their hauling done. If the truth were known, this is in reality the most unsatisfactory and unfair method for the reason that as a rule the hired truck contractor does not bear the same measure of responsibility as does the road contractor. He is dependent on transient employment in order to make a living and for that reason he does not care to assume the responsibility of fulfilling his contract to the letter. So far as details are concerned, he is no more interested in the operating costs than has been the contractor himself and as a rule when he finds that he is not making any money on the job, he breaks his contract and the road contractor finds himself in a pinch.

"For this reason, if no other, it should be more to the advantage of the road contractor to own his trucks. If he will pay the necessary attention to operating costs so that he might know where he stands there would be no reason why he could not make money on his truck operation. The sooner the road contractor realizes the necessity of paying close attention to the details of his operations the sooner these difficulties will be eliminated."

Mr. F. J. Alvin, General Manager of The United States Motor Truck Co., Cincinnati, Ohio, writes:

"There is one old true principle in business that is sound, and that is, that the successful man in any field is judged by his ability to do things right and proper, and being equipped to see that the work is done properly.

"Now the contractor, or sub-contractor, who owns his equipment is in position to know exactly what can be done, and what should be done, and he can undoubtedly be able to accomplish better results.

"Naturally, owning his own equipment, he is interested in seeing that it is kept in order and ready for work, and that the great efficiency of development is maintained and kept to the highest standard that this class of work should be kept.

"To my mind the successful contractor doing large construction work is placed at a decided advantage in being able to provide his own equipment, because he then can insist on things being done the way he wants them without any interference or having causes develop over which he has no control.

"There is one more important idea in connection with the contractor owning and operating his own motor trucks and that is, he can insist on the high character of the men employed in this work, and be able to maintain a competent force acting under the direction of an executive head.

"This company has had quite a lot of experience with successful road contractors, and some of them who own and operate a large number of our trucks have been able to accomplish a great deal more than those who relied on hiring different equipment.

"Of course a great deal of successful work is done by a large contractor subletting the work to sub-contractors who in turn own their own equipment, and the writer does not wish to put himself on record as being opposed to the hiring of hauling contractors to do the hauling on construction jobs, because at certain times this work is so enormous and of such a large character, that it is absolutely necessary that sub-contracting be done, but as a matter of good business it does seem to me that any contractor doing road building is in a much better position owning and operating a good portion of his motor truck equipment, because it enables him successfully to set out the method of operation along definite positive plans that means the greatest efficiency and at the least expense."

Mr. H. L. Dewey, Sales Engineer of the Republic Truck Sales Corporation, Alma, Mich., writes:

"From our knowledge of motor trucks in road building service, it is a fact that most motor trucks equipped with dump bodies and hoists or body equipment adapted to road construction work, have been owned by individuals or separate hauling companies who have contracts with road contractors for moving road building material, and that road contractors have hired their trucks in the past.

"We know of no reason why this condition exists except that it relieves the contractors of a certain amount of worry and trouble in operating trucks; but it has been to their disadvantage, as they cannot control the trucks doing their work, especially when they need them most. They are at the mercy of the truck operator. When they own their motor truck equipment they are able at all times to control the moving of road building material at any point along their road construction job.

"It would seem to the writer that this would be a very vital question with the road contractors themselves where they may possibly have two or three jobs under construction at one time and the trucks could be moved to the different jobs wherever they were most needed. And at the end of the road building season the contractor would have motor trucks ready to start work the next season without the possibility of a delay waiting to secure a sub-contractor to move his material.

"It also might be mentioned that road trucks are generally in great demand at certain seasons of the year and it is almost impossible to secure sub-contractors with motor trucks during the busy period, unless the road contractor foresees this condition and secures the promise of this service far enough in advance so he will not be handicapped in his work. Road contracts are let to contractors with the understanding that the work will be done on a certain date and it is necessary for the road contractor to give a bond guaranteeing that the work will be completed at that time.

"We believe this subject is a very important one and that if enough publicity is given it to road contractors in general this condition could be changed, which naturally would make it much easier for truck manufacturers to get to the proper officials or contractors and present their truck proposition, without unnecessary loss of time and trouble in closing sales. This seems to have been the greatest difficulty in trying to promote sales of trucks for road building purposes. Instead of interviewing the road commissioner and the road contractor and then the sub-contractor for hauling the material, it would only be necessary to call on the road contractor himself to present the proposition."

Mr. C. C. Frame, Transportation Engineer of the Service Motor Truck Co., Wabash, Ind., writes:

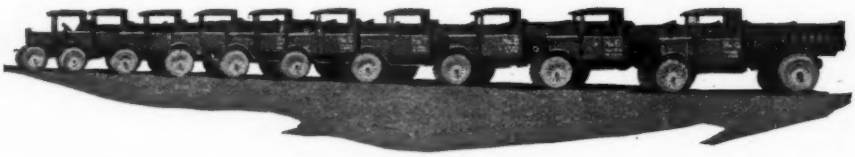
"We have always considered this question more or less individual with contractors. If a road contractor can hire his hauling done for less than he can afford to operate his own equipment and the hauling contractor with whom he deals serves his interests as well as he could himself it would, of course, be to the advantage of the road contractor to hire his hauling done.

"We personally are becoming more and more of the belief that motor truck operation is a business of its own the same as other large agencies of transportation.

"Knowing what we do of the results obtained from motor trucks by individual

KISSEL

Designed and Produced this Fleet of 10
SPECIAL ROAD-BUILDER'S TRUCKS



For C. F. LYTLE, Sioux City, Iowa,

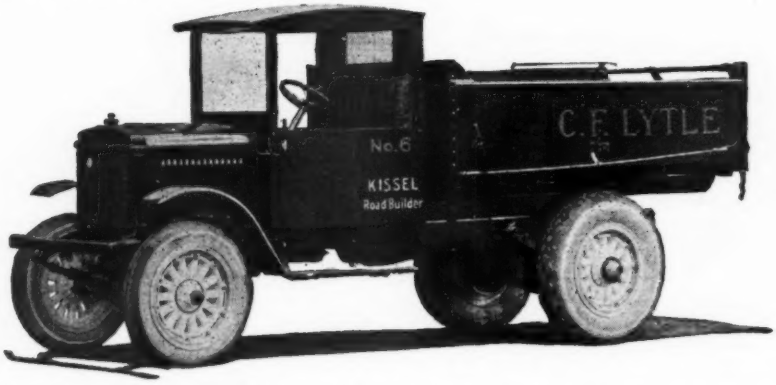
one of the largest contractors and building engineers in the country

The trucks are now working on Mr. Lytle's contract of constructing 18 miles of 20-foot cement road, 8 to 11 inches thick, with gutters.

Each truck is delivering two batches—1¾ cubic yards each ot sand, gravel and cement—at the proper speed, to keep the mixer continually working at capacity.

Lytle's fleet of Kissel Special Road-builders' trucks, which includes a Ton Express, Kissel's new 35-mile per hour truck for speedy auxiliary work—shows the advantage contractors are enjoying by availing themselves of Kissel's fifteen years' experience in truck building and transportation engineering service in producing specific units for specific contractors' requirements.

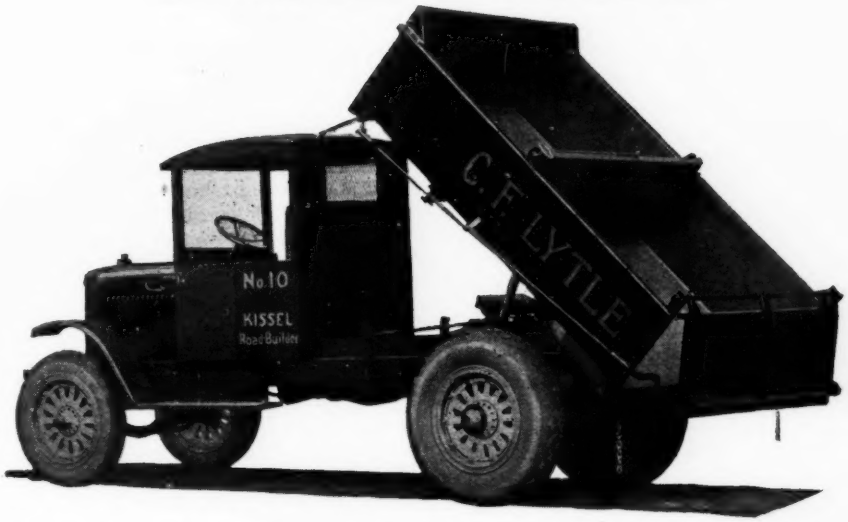
Kissel has a special plan that saves contractors money and time on their hauling. Send for the facts.



KISSEL MOTOR CAR CO., Hartford, Wis., U.S.A.

SPEED—ECONOMY—DEPENDABILITY

KISSEL



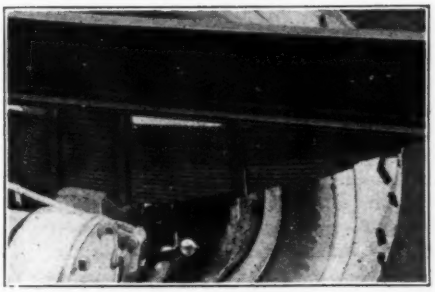
Designed—Geared—and Powered for Flexibility—Proper Speed—100 Per Cent Service

Kissel Road-building Trucks are specially designed and adapted to contractors' individual requirements—which, like in the case of C. F. Lytle, will prove a speedy, economical and dependable haulage service.

Whatever the size of your contract, the Kissel engineers will design a fleet of special units—working as a unit and hauling by a system that not only reduces the cost per load to a minimum, but renders a better haulage service.

Kissel Qualifications—Facilities—Experience and Organization emphasize Kissel's ability to specialize on Road-building Trucks and Equipment, from the regular Heavy Duty Road-builder and Dual Hopper Dump Body Truck to the Special Road-builder's Truck like Mr. Lytle's.

Double Frame and Extra Heavy Springs for Strength and Durability



Kissel Engineering Service is at your disposal. Send for specific details of road building service and names of prominent Kissel fleet contractors.

Brief Specifications of Kissel Special Road-builder's Truck

Short wheelbase—special double channel frame for strength—36x6-in. front and 42x9-in. rear Pneumatic Cord tires—special steel body with special center partition and gate to handle two batches—powerful motor—special sectional driver's cab—Horizontal two-cylinder Hoist—tire pump—***the whole job geared and powered for flexibility, power and proper speed.***

KISSEL MOTOR CAR CO., Hartford, Wis., U.S.A.

SPEED—ECONOMY—DEPENDABILITY

owners, we are convinced that the great majority of truck owners are not obtaining anywhere near the transportation results from their trucks that they are capable of.

"We are, therefore, of the opinion that it is highly possible for a motor transportation company to so manage its trucks that it can haul for individuals for less than the individuals can do the hauling themselves.

"We have a booklet 'Transportation Engineering and Truck Usefulness' which very generally covers this point.

"In practice, however, there are at the present time many advantages to be gained by the road contractor in owning his own truck equipment. In the first place he has complete control of their operation and can work them as many hours a day as required and also use them for a variety of purposes which would probably not be covered in the contract with the hauling contractor.

"For example, if he is having his hauling done by the yard mile, he could not expect his contractor to make emergency trips for a small quantity of material.

"A road builder owning his own truck equipment could also interchange different types of bodies and perhaps road oiling machinery on the same truck. He could also utilize the truck for pulling scrapers, etc., and where the road operations are large enough to utilize a man in charge of the trucks it would very likely work to the advantage of the road builder to own his own truck equipment.

"At the present time there seems to be a condition existing among road builders in regard to motor trucks, the same as with other road building equipment. That is, the road builder usually expects one season's contract to pay for all the machinery involved. This may apply to other machinery such as scrapers, etc., but is different with motor trucks since good motor trucks should also be looked upon as a business asset capable of returning an income every day and if not engaged in road work can be utilized for other purposes the year around.

"If more road builders would look at the motor truck from this angle they would undoubtedly recognize more reasons for owning their own truck equipment."

The following very interesting discussion was submitted by a gentleman who modestly requests that his name be withheld and we must, of course, be governed by his wishes although we should like to give him the credit to which he is entitled for his contribution to the discussion of this important subject:

"Road contractors, unlike poets, are made as well as born. They are a canny, close-figuring, shrewd class of men and usually have very excellent reasons for the practices which they follow in connection with their business.

"When road contractors, as a class, do thus and so, we have reason to believe that they know why they are doing it. They have learned by experience, as a rule, how to figure costs so that there will be some slight margin left after the bills are paid, which margin will enable them to justify their being in business. If it were the universal practice of contractors to hire their hauling done instead of doing it with their own vehicles, we should feel that there was no possible ground for an argument and any time devoted to prove that contractors should own their own trucks, would be just that much time absolutely wasted. There is, however, a considerable variation in practice. Some contractors do substantially all of their hauling by means of their own trucks. Others contract for practically all their hauling service. Between these two extremes there are other contractors who own trucks and do a certain portion of their hauling but who contract for the balance.

"To the man who sits beside the road and views the question from the outside, it would seem as though there should be but one logical position to take on the question of truck ownership by the road contractors. The reasons why it would seem feasible and desirable for road building concerns to own their own motor equipment may be briefly stated as follows:

"1. Trucks are always available for service when needed. The man who depends upon contracting his haulage may find difficulty in securing reliable hauling contractors when and where he desires their services.

"2. When the contractor owns his own trucks, they may be readily adapted to various services. If he needs trucks for hauling timbers he may remove the dump body from one of his regular service trucks and put on a body equipment which will be suited for that purpose.

"3. Again, he may divert his trucks to special services. If he has contracted with haulers for so much per yard, the man who holds the contract will wish to keep his trucks busy on that yard haulage and will resent having the trucks diverted to any other work, no matter

how necessary it may appear to be. The contractor, on the other hand, who owns his trucks can put them at work where, when and on such kinds of work as need to be undertaken.

"4. Again, the contractor may be carrying more than one job at a time. His maximum haulage requirements on the different jobs may vary at different times. If he owns his own trucks he can readily divert them from one job to another as the need may require. If he is getting his hauling done by contract, he may find it difficult thus to shift trucks from one place to another, particularly if one truck job offers a better opportunity for profit to the contract hauler than does the other.

"5. Why should the contractor not make whatever profit there is to be made on the hauling, as well as on any other phases of the contract? Undoubtedly the men who do his hauling on the contract basis, figure so as to make a profit. That profit which he pays to the contract haulers must come out of his general profits on the job as a whole. Why should he not retain that profit by doing his own hauling?

"6. Trucks owned by the contractor are likely to be better serviced and to stay on the job more continuously than trucks owned by hauling contractors. The road contractor who owns his own trucks will need to have enough of them so that he can afford to keep them properly serviced under the direction of a capable mechanic. While the hauling contractor on the other hand, with but two or three trucks may be so engrossed in seeing the yardage mount up as to neglect his trucks to his own ultimate loss and to the delay of the construction operation.

"7. Again, the contractor who owns his own trucks will be more likely to use them on all occasions where truck haulage is most economical no matter how relatively small the amount of haulage may be. If he owns his own equipment, he will utilize that equipment where it can be utilized to best advantage. If, on the other hand, he must contract for his truck haulage, he may often find times when a certain amount of trucking would be profitable but because the amount is comparatively small, he will use some other form of equipment which he may have and with which he can do the work, although at greater expense, rather than to hunt up a hauling contractor to handle it.

"Of course the road contractor reduces his initial investment materially by hiring his hauling done instead of doing it himself. He would reduce his initial investment still more by hiring the mixing of his concrete done by another's equipment and hiring the placing of the concrete on the road done by other's equipment, but the man who hires all his work done in a road job is likely to find he is contributing his profits to the people who have actually furnished the equipment to do the work.

"A farmer might hire his ground plowed and harrowed and seeded and also hire the equipment for handling the harvest. Very few farmers, however, follow that practice, because they feel that if any profits are to be made in putting in or harvesting the grain, they prefer to make them themselves. Further, they know that they can do the work at seasonable times, whereas, if they had to depend upon hired equipment, they would also have to depend upon the convenience of the man who owned it. The contractor who owns his own motor trucks can bid with assurance. If he is so fortunate as to secure the contract, he can go ahead whenever he will and will not be obliged to wait for the convenience of the men who are to furnish the equipment for the work.

"8. Again, it would seem as though the ownership of equipment would raise the standard of reliability and responsibility of the contractors involved. If no initial investment is required, there is nothing to prevent any man with a little nerve from entering the contracting field. The results are likely to be that the entire contracting business will be brought into disrepute and road construction will be, to a constantly increasing extent, done under direct County and State authority by day's labor instead of by contract."

Mr. W. E. Blodgett, advertising manager of The Autocar Co., Ardmore, Pa., writes:

"There are many reasons why road contractors should operate only their own motor trucks:

"1. The efficiency with which all of their machinery is able to operate is dependent upon the constant flow of materials from railroad sidings or storage, to the mixer or tamping machine.

"2. The length of time in which their capital is tied up is dependent upon the early completion of the work.

"3. The return they are able to get from their overhead investment and permanent organization is dependent upon the earliest possible completion of each job.

"4. The time that they can possibly start a new job, with its additional profit,

depends only upon the earliest possible completion of their present contracts.

"5. only by owning their own motor trucks can they control absolutely the transportation of material, which is the one main essential in making them a profit.

"6. By owning their own motor trucks they can control absolutely the size and type, avoiding damage to the sub-grades.

"7. By owning their own motor trucks they can insure themselves of having their transportation done at the lowest possible cost.

"8. Road contractors must of necessity make the maximum progress on days when the weather is suitable, as weather conditions frequently mean the difference between a profit and loss on the closely bid contract.

"They cannot afford to leave out of their control factors that can be controlled.

"9. By a moderate investment in well selected motor trucks and a system of moving materials with one handling from railroad sidings to the mixer, contractors can do away with the much larger investment in industrial railways, etc."

The editor will be much pleased to continue this discussion at the readers' pleasure. We expressly invite readers to submit their views on this important topic.

HIGHWAY TRANSPORT CLEARING HOUSES

(Editor's Note: The following matter is the full text of the report of the committee on Highway Transport Clearing Houses, presented at the 1921 convention of the National Highway Association on April 29, 1921, at Detroit. Tom Snyder of Indianapolis is chairman of the committee.)

As chairman of this committee I have made many inquiries as to just what should be the function of a Highway Transport Clearing House, or what should be the complete character of service rendered by a Highway Transport Freight Station.

My inquiries covered a wide field of motor transport activity, and the answers were as varied in definition as the number of inquiries made.

It is perhaps not unusual that as yet, there should be no clear, well-defined point of view on either of these questions, as experience, the great teacher, has had little opportunity of working out these important factors of motor transport application.

I am convinced, however, as a result of these inquiries and their answers and as a result of my own experience in motor transport, that a Motor Truck Terminal and Clearing House is assential to successful motor transport, as freight terminals and clearing houses are to steel rail or water transportation.

The theory that all shipments to be transported by motor truck can be picked up at the shippers platform by the transport truck, and that the highway transport truck can also deliver to store door, or be successfully applied as a cartage vehicle must be given up.

This statement may excite considerable opposition, because so much has been written and said about the motor truck rendering a service direct from shipper to consignee and that because of such service unnecessary handling of freight has been saved, which is all true, but which will be the special or rare case when motor transport is broadly applied as a definite link in the whole service of transportation.

I know of no important industrial center in America from which (within the next six years) less than 8 different Motor Transport routes will be operated, and from some centers this number may be increased to 20 or 30.

It would be a daily occurrence for some shippers to have consignments for each of these routes, and limited platform space, which has long been a menace to American industry, would prevent the transport truck from each of these routes picking up their route consignments at shipper's platform space.

Many shippers in Indianapolis, Cleveland, Cincinnati, Louisville, Chicago, Milwaukee and other centers who now have access to the better short haul motor transport service will not use it because of their limited platform space.

Many shippers have said to me that they would gladly use motor transport for all short haul consignments if their shipping department could load to their own freight delivering vehicles, to be dropped off at a motor transport terminal while making daily deliveries to all other terminals.

There are four definitely fixed reasons why Motor Transport Freight Stations and Clearing Houses are essential to successful motor transport operation.

1. Shipper's limited platform space, which is too often inadequate to serve his own demands.

2. Most large shippers maintain regular cartage equipment which makes regular daily trips to steam, electric, and water transport terminals, and could add consignments to motor transport terminals at less cost than transport trucks could pick up, providing, however, truck terminals would be properly located.

This applies to the endless number of small consignments, which makes up the major portion of all tonnage for all short haul shipments.

When full truck load or even a comparatively large consignment for highway transport is made, a clearing house record on cost of cartage should determine when it is most economical for the transport truck to pick up at shipper's platform.

3. Until highways will sustain tonnage and permit speed in motor transport, it is economically necessary that this mode of transportation confine itself to the service of transporting the higher class of commodities.

The motor truck renders an express service-plus, but only through a motor truck terminal and clearing house can highway transport schedules be established and maintained or sufficient tonnage in express, first and second class freight secured to make it a real factor in transportation.

4. Generally speaking, motor transport is as yet an indefinite thing, it lacks substantiality, responsibility, dependability; the general shipper can not accept it as a definite phase of transportation as he has accepted the steel rail.

A public Motor Transport Terminal and Clearing House is a gateway to and from all highways. It will supply that definite point of contact which highway transport now lacks; it will indicate substantiality, responsibility and dependability which the shipper wants; it will become a crystallizing point from which an analysis of possibility and application can be made; it will make every citizen in every industrial center of America the consignee of every producing farmer within 50 miles of that industrial center; it will put every rural merchant within 50 miles but 6 hours away from his base of supply.

The highway will never serve its ultimate purpose until every citizen, consumer or producer has dependable and beneficial transportation access to it, and this is not possible except through a highway transport terminal.

Character of Motor Transport Terminals

Large industrial centers with well populated surrounding territory will require an outbound and an inbound building or section.

These terminals could be established and sustained as private enterprises and be made profitable through a terminal cwt. or package fee to be added to the transportation charge, and through the operation of a cartage which would be in great demand on pick ups and deliveries to consignees and from shippers who do not operate their own cartage vehicles, and from thousands of individual citizens who through highway transport and motor terminal service will become the consignees of agricultural producers.

These terminals should be established and sustained through the cooperation of Wholesale Shippers' Associations, Farm Federations and Motor Transport Organizations.

The building should be long and narrow, providing the greatest possible amount of platform space on each side of building, insuring relief from building, platform or vehicle congestion.

The building should be divided into route sections, local cartage vehicles delivering to platform on one side of building within route sections according to consignments, these consignments handled through narrow building to outbound platform for shipment that day or left within building if scheduled for following day shipment.

The inbound building or section should be of the same character, permitting inbound transport truck to unload cargoes on one side of building and local cartage vehicles to clear from opposite side.

Because of the flexibility of motor transport, terminals will be very well cleared daily.

For outbound terminal, shipments consigned to routes over which less than daily service is rendered should not be received earlier than one day prior to scheduled departure of truck.

For inbound terminal, local cartage service could easily keep terminal clear.

Schedules should be established over all routes offering tonnage in exchange for service, the terminal clearing house keeping all shippers informed as to schedules, transport rates and service offered.

Many private truck owners can be found within or around industrial centers with whom contracts can be made to operate over routes on schedules, if the terminal clearing house will centralize the industrial demand for service. It is very evident, however, that a standardized fleet of trucks fully under the direction and control of a terminal clearing

house system will render the most dependable and the most economical service.

Dry and Cold Storage Warehouses as Motor Transport Terminals

All dry storage warehousing firms who see the great changes in transportation and distribution which highway transport is rapidly bringing about are providing liberally for motor truck platforms.

Large manufacturers of common commodities are already consigning to warehouse for distribution from that point, to store door any where within motor transport service from the warehouse, and by various sales systems eliminating the jobber, the broker, and the wholesaler.

Increased motor truck platform space is already in great demand at cold storage warehouses, because farm bureaus and federations are instructing agriculturalists to transport by motor truck to cold storage, avoiding the commission broker and holding their season's crops for the unseasonable market periods, Farm Bureaus and Farm Federation Committees acting as sales agents.

In smaller towns and cities in which highway tonnage is not great enough to sustain a motor transport terminal, storage warehouses are rapidly taking on this function and because many of them operate a cartage business in connection with warehousing, find that it fits in splendidly and contributes to their regular line of activity.

Thus the terminal problem for motor transport throughout America is not as great as it has been considered, the greater problem being that of limited platform space at warehouses and at shippers' places of business.

The trailer is rapidly being found a means of relief from the problems of limited platform space, and is perhaps best illustrated in several routes operated out of Indianapolis.

Where shipping points along these routes receive as much as one or two tons, the consignments are loaded on a trailer and delivered to a local warehouse or cartage man who delivers to store door from trailer while the transport truck goes on its way, and on its return picks the trailer up, often well loaded for the return trip.

Trailers are also used as highway clearing houses in the transportation of milk, two trailers to truck being used on some routes.

These trailers are dropped off at important highway crossings loaded with empty cans, the transport truck going on to the end of the route and returning loaded picks up the trailers which have been loaded with full cans by smaller pick-up trucks and on a scheduled system which avoids delay for the transport truck.

Platforms are also being built at important highway cross-roads from which the transport truck picks up consignments or to which it unloads a great variety of commodities shipped to farmers in the neighborhood of the platform.

These platforms are small clearing houses and have done much toward increasing highway transportation in Indiana.

Interurban Electric Railways have entered into competition with the motor truck in the transportation of live stock to the Indianapolis Stock Yards, but before it was possible for them to secure any portion of this business it was necessary for them to build stock yards and loading platforms at many points along their routes.

The Electric Roads have been trying for several years to secure this business, and a transport rate of 75 percent less than motor transport rates were offered, but it finally took the terminal clearing house and definitely scheduled service to get a portion of the business.

The cost of operating railway terminals upon the basis of cwt. and the relation of this cost to the transportation receipts for hauls of various distances were apparently never analyzed until within the past few years.

It must have been depressing to many of the larger carriers when it was learned that the terminal cost per cwt. on the greater portion of their short haul tonnage was greater than the total transportation rate allowed.

The many almost insurmountable causes for this fact are due principally to yard, trackage and switching limitations which would not apply at all to motor transport terminals.

Surveys in many of America's industrial centers have disclosed that terminal building, yardage and trackage expansion sufficient to meet the normal transportation demands upon steel rail carriers is physically and financially impossible.

Because of the flexibility of the motor truck, with its trailers, semi-trailers, and demountable bodies, and because every highway, street or alley becomes an outlet for the movement of tonnage, the Highway Transport Terminal will never be subject to the limitations of steel rail terminals.

EDITORIALS

THE WATER WORKS SITUATION

In this issue we are devoting more than the usual amount of space to water works matters because of the annual convention of the American Water Works Association soon to be held, at which copies of this number will be distributed. Several very interesting articles on water works subjects, written for our exclusive use, are published in this number.

The time is appropriate for considering the situation in the water works field. The private companies were very hard hit, of course, by advancing costs, since they had only a moderate fixed income with which to meet the increased expenditures. Some relief has been granted them in rate increases. Municipal plants were, in many cases, on such a basis that water funds were used for general purposes, so by practicing some economies and using their funds for their own needs water departments have managed to get along fairly well.

Of course, there has not been a large volume of new water works construction and the reconstruction and extension of old works has not been great. As in every other line, therefore, water works improvements have not kept pace with the demand, but have been postponed from year to year, until now there is an accumulation of needed projects which will represent a cost running far into the millions of dollars. Much of this work should not be postponed any longer in the expectation of lower costs, for while costs must come down some time, it is doubtful economy to use overtaxed, insufficient and inefficient works too long just to save a small percentage on the cost of new improvements. A revival of construction is likely to be accompanied by rising costs again, as we are not likely to get back to the pre-war price level on construction for many years to come. For these reasons work should go forward now on needed water works improvements.

RESERVE WATER FILTER CAPACITY

Water filtration plants are frequently, if not usually, built too small. Water consumption usually increases rapidly after the installation of a filter plant, and new plants are frequently overloaded while serving the population for which they were designed, due to the increase in the per capita consumption of the more attractive and safer water produced by the plant. For this reason alone filter plants should be made of ample size.

But there is another reason for making these plants of generous proportions, and that is to provide reserve filter capacity. Additional filter capacity should be provided to take care not only of peak loads, but also so that one filter at any time can be put out of service for inspection and overhauling. Sufficient attention has not been paid, in the past, to this need for reserve filter capacity.

THE GREAT AMERICAN DETOUR

The detour is rapidly becoming a national institution. It is still possible to make it more a convenience than a highway horror, but if this is to be accomplished thought must be taken and some money spent.

During the era of highway construction, on which we have as yet scarcely more than entered, detours will be frequently encountered, by the tourist at least, and it would be well to formulate a rational detour policy now. Certain fundamentals should be kept in mind by the engineers whose business it is to lay out detours and prescribe their use.

First of all, it should be recognized that the purpose of the detour is to facilitate travel quite as much as it is to safeguard construction operations. Traffic should not be diverted from the main highway unless there is a mighty reason for doing so. This seems so obvious that it would not be stated here but for our observation of a case last year, in which the main outlet, in one direction, from a very large city, was closed for months while the road was, presumably, under repair. During this time an exceedingly heavy traffic was required to drive over ground so rough that it was a serious question whether those riding would not be injured, not to mention the damage to hundreds of expensive cars that bumped over that detour every day. After some months of this the main road was again opened to traffic and was found to be in practically the same condition as when

first closed. Just how this came about is unknown to us, but evidently somebody had blundered.

Detours should be kept as short as possible, for aside from their greater roughness they are naturally longer, as a rule, than the road which they temporarily supersede. The man who lays out a detour should try to make it as short and as smooth as possible; his job is only half done when he gets rid of traffic for the time being, for he must take care of it at the same time.

Where the detour passes over an uneven surface it is well to spend some money to make of it a fairly smooth roadway, if this can be done with the usual road grading and surfacing machinery, especially where the traffic is considerable and the detour is to remain in operation for a month or more. There are precedents for spending money to secure merely a temporary result, as in snow removal, for example.

Some detours are quite passable, others not too bad, while still others are misdemeanors, if not crimes. It is well to remember that the public is very resentful of being thumped with a detour.

INSTRUCTION OF ENGINEERING STUDENTS IN ADVERTISING

An interesting departure in engineering education has been observed at the Iowa State College, where a course in technical advertising is being conducted, with an enrollment of 25 men. These men are students in civil, mechanical, electrical and chemical engineering and in architecture. Certain features of the course are of general interest.

The first four weeks of the eleven-week course are devoted to a study of the fundamental principles of advertising—that is, the place of advertising in business, the methods of advertising and the psychological features of attention, interest, desire, conviction and action. At the end of four weeks each student establishes a hypothetical business, in which he markets some new, simple technical product. He is assigned a definite advertising appropriation, and on that basis devotes the remainder of the time to the development of the initial advertising campaign for his product. He selects the advertising mediums he will use, lays out his advertisements, works out a few direct mail pieces and some sales letters. During the course the class studies a considerable number of pieces of advertising copy which have been published in the technical press, with the idea of finding their strong points and their weaknesses.

In a two-hour course running through but eleven weeks it is not possible to go very deep into the subject of advertising, but enough information is given the men to enable them to go on with the study of advertising by themselves later on.

We have been particularly interested in the course of study briefly outlined, and should be glad to see other engineering schools add similar courses. It will mean much to many of the students to have the business world revealed to them in this way, and by broadening their outlook as well as their knowledge, will increase the possibility of their finding their proper places later on. Many engineers would like to get into manufacturing, but do not know how to go about it. Young engineers who enter manufacturing establishments through advertising and sales positions will learn how to get into manufacturing for themselves later on if they wish to do so. Men of the type who study engineering in colleges are needed in manufacturing, and in advertising and selling also. Some day engineering graduates will fill many responsible positions in the advertising departments of the engineering manufacturers.

FIREPROOF SCHOOLHOUSES

There is now a shortage of schoolhouses, just as there is a shortage of buildings for business and residential purposes. The great movement of the people to the cities during the past few years, when building operations have been so severely curtailed, has, of course, filled existing school buildings to overflowing. In many localities school is being held in portable and temporary structures, and in some places in churches.

There has been ample time for the proper planning of new school buildings, so when construction of this type of buildings is resumed the errors of the past should be avoided and we should build better than ever before. What remains of the idle period should be utilized in proper planning.

Surely the time has come for the fireproof schoolhouse. Every school building, containing four rooms or over, should be built of the highest type of fire-resisting construction.

With the need for new school buildings so clearly defined, there is no excuse for cheap or flimsy construction. There must be no more fire-traps built for helpless school children.

WIDTHS OF ROADWAYS AND SIDEWALKS IN MUNICIPALITIES

(Editor's Note: The following data and discussion are from the report of a committee of the National Highway Traffic Association, of which Mr. Hugh J. Fixmer, Paving Engineer, Board of Local Improvements, City Hall, Chicago, is chairman. This report ,written by Mr. Fixmer, was presented at the annual meeting held in Detroit April 29, 1921. The report gives emphasis to the fact that roadway widths should not be standardized. Each street presents a separate problem requiring engineering study. The cost of street improvement is too great to permit guesswork as to the width of the paved roadway. The width should be designed to fit the use of the street. It must accommodate the traffic (whether parked or in motion) and the use of the abutting property. The formulas, in this discussion, are introduced to indicate a basis for study of the problem and outline the main factors having a bearing on it.)

It is quite obvious that the width of the street is to be determined by the use to be made of it. The proper width of street is a summation of the width of roadway, width of sidewalks and extra or reserve width. The extra or reserve width is set apart for parkways, to add beauty and comfort, and to provide for future expansion of roadway and sidewalk width. In the typical city where the width of street is fixed and defined by buildings, the width of roadway and sidewalk must be carefully proportioned. Where these widths prove inadequate to accommodate the traffic the street must be widened by condemnation. Where this cannot be done, because of physical, legal or economic conditions, the traffic must be restricted and regulated by police power.

Width of Roadway

The width of pavement or roadway is determined by traffic needs, by tradition, by esthetic requirements or by limitations of site or cost. In the city the value of the pavement to the users is of paramount importance. The pavement must prove safe and comfortable to use, must be truly economic, must present an agreeable appearance, and must accommodate the abutting property and the character and amount of traffic using it.

The realization of the above qualities is intimately affected by the factor of width of roadway. Owing to the great increase and diversified use of motor vehicles, the fundamental basis of pavement design today is to fulfill the needs of the traffic; to serve the users of the street in an efficient manner. The following quotation is from a paper presented before the 1920 annual meeting of the American Society of Municipal Improvements by Mr. Robt. Hoffman, Chief Engineer, Department of Public Service, Cleveland, Ohio:

Two Ponts of View on Roadway Widths

"The determination of roadway widths may be considered from two different points of view. One is from the viewpoint of appearance, governed by rules of proportion, or by making provision for predetermined widths of sidewalk strips or for lawn and parking spaces. The other viewpoint is that of traffic accommodation.

"The first viewpoint applies principally to parkways, boulevards and certain classes of residence streets where beauty and proportion largely control the design rather than economy and utility. Making the roadway from 50 to 60 per cent. of the street width between property lines will, in many cases satisfactorily suit conditions. The design of the planting strips and lawns will, however, nearly always control the width and arrangement of the paved roadways. Even here the expected traffic should receive consideration, but its subordination to other conditions may be perfectly logical and free from criticism.

"Consideration of roadway widths from the second viewpoint, that of traffic accommodation, obviously applies to the greater number of cases, and should be the prevailing point of view when considering any basis of design or the standardization of widths."

Kinds of Traffic

There are five general classes of traffic using the city street. These are: Pedestrian, horse drawn, motor driven, street railway and stationary traffic. Stationary traffic consists of vehicles loading or unloading merchandise, and vehicles, mostly motor driven, appropriating the public space for parking. Since all classes of traffic have the common right to use the street, the street should be designed to afford each class the maximum of comfort and safety without abridging or destroying the rights of the other classes.

Effective Width

The effective width of roadway is that part available to moving traffic, and is

affected by the presence of street railway tracks, by the provision for parking vehicles, by the custom or necessity of backing vehicles against the curb to load and unload material, by slippery surface, by excessive crown of surface, by accumulation of snow and refuse and by uneven or worn out pavement surface.

Requirements of Traffic

The width of roadway required for traffic is a function of the necessary clearance, of the width and permissable speed of the vehicles and the volume or amount of traffic. The relation between roadway width and width of vehicle, for each line of traffic (standing or moving), is given by the following formula:

$$W=B+C+S/10 \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

S being the permissable maximum speed (in miles per hour) of the vehicle traffic.

W = required width of roadway for one line of traffic parallel to the street axis (in feet).

B = width of vehicle (over all) in feet.

C = lateral clearance factor, varying from ½ to 1 (Ft.).

Thus in order to fix the width of roadway to accommodate the character of traffic the widths, particularly the allowable maximum, of all vehicles, together with the permissable speed must be known. Where vehicles stop or park parallel with the street axis the required width from the formula is over all width plus one-half foot. Where vehicles are permitted to park at an angle or back against the curb to handle goods, the width must be increased from 6 to 12 ft. over the width needed when standing parallel with the curb. The space to be provided for parking or so called stationary traffic must be definitely settled.

To determine the effective width, or width to be kept open for moving traffic, we must know the number of moving lines of traffic to provide for.

The distance required to stop a motor driven vehicle equipped with proper brakes, road in good condition and driver alert, is determined by the following formula:

$$D = S/10 \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

D = Distance in feet to stop vevehicle.

S = Maximum allowable speed in miles per hour.

The headway required for fast moving vehicles varies with the maximum speed, the factor of safety assumed (to allow for poor brakes, possible slipperiness, time for driver to act), and the length of the vehicle is:

$$H = DF + V \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

H = Headway in feet.

F = Factor of safety (ordinarily equal to 2).

V = Length of vehicle in feet. V is important only at low speeds, and varies from 10 to 30 ft. depending on kind of vehicle.

The maximum number of vehicles* per hour per line of moving traffic is given in the following formula:

$$N = \frac{5280M}{H} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (4)$$

N = Maximum number of vehicles per hour per line of moving traffic.

M = Assumed average speed in miles per hour.

The number of lines of traffic to be provided for should be based on the future use of the street. A traffic census is of little value unless carefully interpreted, and then is only important as an aid to judgment.

The total width of roadway to accommodate the character of traffic using a given street is the summation of the number of traffic lines required for moving and stationary traffic.

A given width reaches its greatest capacity when speed is uniform or average speed approaches the maximum speed. This ideal condition is never reached and closely approached only on long stretches of open country road or certain boulevards.

On the city street the speed is restricted to a low average, due to frequent cross traffic, presence of car tracks, and mixed character of traffic. To accommodate an increase of traffic, the roadway must be widened or the maximum speed reduced and the average speed increased. A double track street railway requires a width of 20 ft. for safe and rapid operation. On streets other than those carrying car tracks the requirements of rapid vehicle traffic indicates a minimum width of 20 ft. for the rapid moving middle traffic.

Regulation of Width and Speed of Vehicle

The necessary width of roadway for vehicle traffic is a function of clearance, width and permissible speed of vehicle as shown in Formula I. Table I shows necessary width for each line of traffic:

$(W = B + ½ + S/10.)$

*See article by author in Eng. & Contg., Apr. 2, 1919, p. 328.

TABLE I. RELATION OF ROADWAY WIDTH TO WIDTH AND SPEED OF VEHICLE.

Permissible speed of vehicles in miles per hour (Min.) Parked or standing parallel to curb (stationary)	Overall Width of Vehicle (in feet) 6	6½	7	7½	8	8½
	Width of Roadway Per Line of Traffic 6½	7	7½	8	8½	9
5 miles per hour	7	7½	8	8½	9	9½
10 miles per hour	7½	8	8½	9	9½	10
15 miles per hour	8	8½	9	9½	10	
20 miles per hour	8½	9	9½	10		
25 miles per hour	9	9½	10			
30 miles per hour	9½	10				
40 miles per hour	10					

Apart from consideration of pavement damage due to impact, tire equipment, etc., the speed must be regulated from the standpoint of public use, safety and economy. It appears that 10 ft. should be the proper width for each line of rapid traffic, and 8 to 9 ft. for side or slower moving traffic. Thus a truck measuring 8½ ft. over all would be limited to a maximum speed of 10 miles per hour, and shoul dnot travel along the middle strip reserved for rapid traffic.

It seems the general concensus of opinion that, until demonstrated uneconomic, the width, length and height of vehicles should be limited to 8 ft, 24 ft. and 12 ft., respectively.

Economic Value of Width

City pavements are expensive, and it is wise carefully to determine adequate width. Pavement cost varies from 50 cts. to $1 per foot in width per lineal foot, or $2,500 to $5,000 per mile per foot in width. It is for this reason that the maximum width should be a minimum to accommodate the needs of the traffic and abutting property. Streets should not be paved too wide where use does not demand it. The regulation of width of vehicles is certainly justified in view of the added cost to accommodate a small percentage of extra wide trucks. The loss occasioned by congestion, detours, restricted business and so forth, due to an inadequate roadway should be determined. This loss, when capitalized, indicates the sum that can be wisely spent to increase the roadway width or construct new trafficways adjoining, above or below the present street surface.

Sidewalks

The main purpose of the sidewalk is to accommodate the foot or pedestrian traffic. Other uses are incidental and can be ignored in determining the proper widths. The width of the sidewalk is often reduced by the presence of poles, hydrants, receptacles and building encroachments, usually stair entrances. The arbitrary, or "practical" rule for sidewalk widths on each side of the street, is given by the formula:

$$Sw = L \times 2 \quad \ldots\ldots (5)$$

Sw = Sidewalk width in feet on each side of street.

L = Number of lines of traffic provided by the roadway.

The traditional method of determining sidewalk width is to make Sw from 8 to 20 per cent. of the total street width. A line of pedestrian traffic is universally taken as 2 ft. in width. It is obvious, therefore, that the effective sidewalk width should be a multiple of two.

In large cities the matter of adequate sidewalk width is vitally important. A formula can be developed for sidewalk width similar to the one used for roadway width. The width for one line of moving pedestrian traffic is taken as 2 ft. This includes allowance for clearance at the average speed of ½ to 3 miles per hour. The distance apart (headway) is determined by speed, or rather degree of congestion, and comfort.

The following formula shows capacity of walk per 2 ft. of width at various rates of travel for various distances apart:

$$N' = \frac{5280\ M'}{H'} \quad \ldots\ldots (6)$$

In which N' = Max. number of pedestrians per hour per line of traffic. (2 ft. width).

In which M' = Average speed in miles per hour.

In which H' = Headway, or distance between bodies. (Allow 2 ft. for body).

In which Sw = Width of sidewalk in ft.

In which T = Total number of pedestrians passing per hour.

$$Sw = \frac{2T}{N'} \quad \ldots\ldots (7)$$

The minimum value of Sw should not be less than 4 ft. In practice 5 ft. is considered a minimum for comfort, in walking two abreast or passing.

In a congested street, due to frequent interruption by cross traffic, etc., with an average speed of 1 mile per hour and distance between pedestrian of 6 ft., we find $N' = 5280 \times 1 \div (6+2) = 660$ persons per hour per 2 ft. of width or 300 per hour per foot of width. This is approximately the maximum, since the clearance (for comfort) varies nearly directly with the speed.

City Planning

The importance of street and roadway widths is now quite well understood by students of city planning. The proper development of property as well as the enjoyment of community life, is dependent on the street layout. Let us trace the history of street widths in the average American city. The universal street and road width east of Ohio is 66 ft., an arbitrary unit based on the "surveyor's chain," this unit being adopted to facilitate computation of areas in terms of acres, rather than from any consideration of traffic needs. This traditional or "standardized" width is inadequate in many places and wasteful in others. Many streets are laid out with the width based on willful expediency or vague imagination, no thought apparently being given to the needs of traffic; accessibility, need of parkways, or future use of the street.

The general rule for adequate street width is given by the simple formula:

$$W = Wr + Ws + Wp + Wg$$

in which

W = total width between buildings.
Wr = necessary width of roadway.
Ws = necessary width of sidewalk.
Wp = width of parkways.
Wg = Reserve width or width necessary to widen roadway and sidewalk when character of street and property changes. Very often Wg is taken equal to Wp, the parkways being absorbed later on in the roadway and sidewalk space. In some cases Wg is laid out between the sidewalk and so-called building line. This is good practice where legal, and later on, enforcible. (See Table II.)

Table II is submitted to show approximate sidewalk and street widths required for modern traffic for usual types of streets, in the average municipality. This table does not represent an attempt at standardization. It appears here to indicate the proper method of determining street width, which should, if possible, be secured when the street is originally platted.

It is still the general custom to determine roadway width on the basis of limitations of site and cost. While this method may be warranted in a few cases, it should be generally discouraged. Some cities have attempted a general standardization by assigning ratios to the roadway or sidewalk width. Usually the roadway width is established at 40, 50, 60 or even 70 percent of the total street width. There should be no general standardization of roadway or sidewalk widths. As stated before, the width should be an expression of the use of the street or the needs of the traffic and abutting property.

TABLE II. ROADWAY, SIDEWALK AND STREET WIDTHS.

Class of Street	No. Traffic Lines	Prob. Lgth. of Vehicle	Prob. Max. Wdth. Vehicle	Max. Speed Allowed	Prob. Aver. Speed	Max. No. Vehicles (per hr.) (No Parking°)	R'dway Width	Sdwlk. Wdth. (Each Side)	Pkwy. or Reserve (Each Side)	Minimum Total Street Width. (Bet. Bldgs.)
Residence street...	2	16	7	20	15	1600	‡20—24	(4)—6	9—12	‡50—60†
Residence street...	3	16	7	20	15	2400	30	6	12	66†
Boulevard	6	14	7	30	20	3270	56	10	22	120
Business street...	4	16	8	20	10	2200	40—48	12	28 to 24*	120*
Through route bus. st. (car line)...	6	20	8½	20	10	3180	60	16	0 to 14*	92 to 120*
Retail bus. st. (car line)	8	16	8	15	5	3520	80	20	0	120
Industrial street...	4—6	24	8½	10	3	1440—2160	44 to 68	10	0	64 to 88
Outlying drive or (road)	2	14	7	30	20	1200	20	4	16	60†

*Allow for future traffic increase.

†Where zoning laws are in effect and character of street is settled. Otherwise require reserve space by establishing 30-ft. "building lines."

‡Side frontage street for local traffic only. (No parking allowed.)

°Where parking is permitted reduce capacity to correspond with number of lines of moving traffic or increase roadway width to accommodate increase in number of traffic lines.

Each street should be studied not only alone but in connection with the general street plan, and widths adopted to fit its use. City planning, with its provision for zoning, will greatly assist in defining the character of the street and thus enable us to design street, sidwalk and roadway widths more efficiently in the future.

PRACTICAL LIMITATIONS IN "SURFACE TREATMENT" OF OLD BRICK OR BLOCK PAVEMENTS

By W. L. Hempelmann, Engineer, Middlewestern Division, Asphalt Sales Department, the Texas Co., 10 S. La Salle St., Chicago, Ill.

At varying intervals the engineering journals record attempts to surface-treat old brick or block pavements. The thought generally is to produce a smooth surface, eliminate the noise, and last but not least, obtain a two or two and one-half dollar pavement for considerably less than fifty cents per square yard. The temptation to get something for nothing prevails in the paving game just as well as in other commercial lines.

Irrespective of one's experience in paving matters, a moment's reflection will convince the individual of the impossibility of building the equivalent of a sheet asphalt or asphaltic concrete wearing surface over an old brick or concrete pavement by simply applying a little road oil and covering it with sand or stone chips. On the other hand, under favorable conditions, the surface-treatment of certain types of roads has been very successful.

Surface Treatment Satisfactorily Practiced in the South

In the South, certain hard roads constructed with coquina rock, shell, limestone, etc., have been very satisfactorily surfaced by an application of an asphaltic oil covered with hard stone chips. The surface of such roads when dry is more or less porous and absorbent and such treatment makes a very smooth, economical road surface, free from dust, and easy to maintain.

In the larger cities it is generally looked upon as an economical procedure, where the physical conditions of the pavements permit, to resurface old brick or block pavements either with binder and top or with an asphaltic concrete wearing surface. One reason is that the traffic in such communities in the main is heavier, the service to be rendered correspondingly greater, and usually the product of an asphalt mixing plant is available.

The Smaller Cities Adopt Surface Treatment to "Save Money"

In the smaller cities the general tendency is to try to get away from the use of what is termed "expensive equipment." This tends to put the official in charge in a receptive mood to consider the surface-treatment of his rough pavements with a bituminous material. Generally the conversation relative to the procedure is about as follows:

"All you have to do is to clean the street, apply the bituminous material liberally, and cover with chips."

The simplicity appeals to the engineer in charge and in the majority of cases, with no experience to the contrary, he agrees to try it out. Within three or four months after such treatment such engineer desires to give his fellow engineers the benefit of his "discovery" and accordingly he writes an article. Frequently, before the ink is dry in the journal containing such write-up, there are some indications that the desired "sheet asphalt surface effect" will probably not be realized and usually after such treatment has gone through a winter and a spring there are considerable areas that have scaled off or others in which the material has been displaced by traffic. The representative who volunteered the construction information either hears about the results or accidentally happens into the city once after he has made the sale of the original material. His reception by said engineer can be better imagined than described. The "Never Again" Club has another new member.

Note Distinction Between Surface Treatment and Resurfacing

The fallacy of surface-treatment of old worn brick or block pavements comes in not being able to provide a uniform depth of wearing surface of uniform density throughout. When we undertake to resurface a brick pavement we are very careful to fill or cushion all depressions even prior to the application of the binder course under a sheet asphalt wearing surface. One of the reasons for this procedure is to insure a uniform density throughout the depth of the asphaltic covering, whether in the low spots it be 5 or 6 ins., or only 3 or 3½ ins., over the high brick.

One of the main points to be borne in mind in the consideration of resurfacing old worn brick or concrete pavements is that the minimum depth of asphaltic sur-

face (i. e. the material over the high points in the old brick pavement) must be such as to be able to absorb the shock of traffic without shattering or disintegrating the upper surface of the old pavement. The malleable asphalt surface must be thick enough practically to absorb the impact of heavy loads at high speed. If this condition does not obtain, traffic may shatter the upper surface of the old brick or concrete, and though the asphaltic mixture adheres to the material with which it is in contact, such wearing surface will begin to peel or come off, taking with it a thin irregular layer of the concrete or brick surface.

When the wearing surface over an old rough brick or concrete pavement is to be an asphaltic concrete mixture we still cushion or fill the depressions and all low places in the old pavement before applying the asphaltic concrete wearing surface. Sometimes the advocates of the surface-treating process of brick pavements will suggest that the larger holes be filled in with stone prior to the general surface-treatment of the street, but in any case it is impossible to obtain a uniform depth of bituminous material and stone to serve as a wearing surface.

What Happens to Thin Covering

Under traffic, as outlined above, with an insufficent depth of uniformly dense asphaltic wearing surface, the high spots in the old brick pavement soon cut though the bituminous material and make possible the absorption of water at such points. Old brick pavements that have been subjected to the use of steel-tired traffic are absorptive and this fact permits moisture to get under the bituminous material. Subsequently, the warming up of the pavement due to the sun's rays brings such moisture to the surface of the brick, i. e., under the bituminous surfacing material. This condition tends to destroy the bond between the bituminous material and the brick and usually can be considered as a factor in helping to cause the surface-treatment to scale off. Usually the average consolidated depth of such surface-treatment (bituminous material and aggregate) is less than ½ in. How many experienced engineers familiar with standard sheet asphalt and asphaltic concrete construction would advocate one-half inch or less of sheet asphalt or asphaltic concrete as a covering for an old and irregular brick pavement? Still, the inexperienced official is willing to try out the surface-treatment with stone as the covering material, the various operations of which must produce a mixture on the old pavement which is anything but uniform.

The Essential Minimum Depth of Wearing Surface

To cover satisfactorily an old brick or block pavement the minimum depth of the bituminous wearing surface applied must be sufficient to withstand the shock of traffic and must be uniformly dense so as not to be displaced by traffic. Naturally this cannot be done by a wearing surface usually less than ½ in. thick on the average. Under very light traffic in small cities such treatments may go through a season without becoming an eyesore, but usually streets of that nature are not surface-treated simply because the demand of traffic does not warrant the expense. In any case, the attempted surface treatment of brick or block pavements, irrespective of how carefully the work may be done, generally leads to grief, and if attempted will subsequently bring up the same job either for reconstruction or resurfacing with sheet asphalt or asphaltic concrete in a relatively short time. The expense of the surface treatment is usually considered wasted or charged to "valuable experience."

SOME PROBLEMS IN CONCRETE CONSTRUCTION

By W. K. Hatt, Professor of Civil Engineering, Purdue University, Lafayette, Ind.

(Editor's Note: It was the purpose of Professor Hatt, in this paper before the Indiana Engineering Society, to review some of the present day problems in concrete construction. He discusses some of those features about which the views of engineers are either in conflict or the data are too few to allow agreement.)

In the year 1916 the results of deliberations of the Joint Committee (on Concrete and Reinforced Concrete of the several engineering societies were available in a so-called joint committee report. At the present time a new joint committee has been dealing not only with generalities, but drawing up specific recommendations, and even regulations, in such definite form that they may be used in the formation of specifications. This committee will probably report during the coming summer.

Materials of Concrete Construction.

Cement specifications have been pretty thoroughly standardized and recent advances have been in the direction of greater fineness. Aggregates are receiv-

ing close attention. The old time specifications, 1-2-4, 1-3-6, etc., are being revised in the light of scientific knowledge of the fundamental principles underlying the gradation of aggregates and the proportioning of concrete mixtures. During the past year there was a wide demand for aggregates which could not be met either because of transportation deficiencies or absence of available supplies. The use of local materials as they were found was forced upon the engineer. In Iowa, for instance, the mix was adjusted to the proportion of sand and pebbles in gravels as found in the pits.

The theory of proportioning concrete mixtures has been investigated very thoroughly by Professor Duff A. Abrams of the Structural Materials Laboratory of Lewis Institute, Chicago. Recent researches in connection with the work of the Hydro-Electric Commission of Ontario have also shed new light upon this question, which may be briefly reviewed:

I. *What Controls the Strength of Concrete?*

I suppose the best concrete will be most like a good natural stone, the particles near together and connected with the thinnest layer of a strong cement. How shall we bring this about? In the first place we must have clean, uncoated aggregates; and second, a strong cement; in the third place and very important, the cement paste of water and cement must be as strong as possible, not too dilute by the use of too much water.

II. *Water in Concrete.*

Water is needed for two services—first, to act chemically with the cement so that it will set; and second, it lubricates the aggregate and allows the contractor to put this more or less plastic mass in position. The secret of getting strong concrete with economical use of cement is to use as little water as possible for the particular job. I will to show later on that the character and grading of the aggregate may control the strength of the concrete through its effect upon the amount of water that must be used.

III. *Amount of Water Required.*

Of course different classes of jobs require different conditions of concrete with respect to its flowing properties. For instance, concrete which is to be put in narrow walls containing reinforcing steel must be quite fluid; a road concrete may be less fluid and concrete in a sidewalk, that is to be tamped, may be quite dry. Up to a certain limit the drier concrete will be the strongest, because the cement paste is less dilute. If all three jobs were to have the same strength we would have to use more cement or richer mix for the more fluid concretes.

IV. *Character of Aggregate.*

Now it may be asked if we can not avoid the excess water and the excess cement required to balance this excess water by some other means, say by changing the character and gradation of our aggregate. The answer brings us to consideration of the effect of grading of aggregates, which grading is generally specified by the engineer.

To introduce this topic let us take a well known case. Everybody knows that you can not produce a strong mortar or a good wearing top to a sidewalk by using a very fine sand, and that the strongest mortar is made with the coarse sand, having, that is to say, over 60 per cent of its volume in the coarser particles between the $\frac{1}{8}$ and $\frac{1}{4}$-in. sieve. Now the reason for this is that to obtain the same working qualities or consistency, the fine sand requires more water and if we use the same amount of cement we get a more dilute paste. We can not entirely make up for this by increasing the amount of cement because then the top of our sidewalk will not wear well. On the contrary with the coarse sand less water is required and there is a stronger cement paste.

The reason in turn that more water is required with the finer sand is that there is a greater sand surface to be wet and lubricated.

We are beginning to think that there is an element in the grading of sand and gravel connected with the surface areas, that must be covered, that controls the character of the concrete. Engineers design concrete sometimes by specifying that there shall be 3 lbs. of cement for every 100 sq. ft. of the surface of the aggregate. Now if the contractor supplies an aggregate that is too fine, that is one with greater surface, the engineer will increase the amount of cement and water to get the same strength and the same working consistency. All this, of course, is worked out by scientific experiments beforehand.

V. *The Grading of Aggregate.*

So that when we are thinking of sand and gravel we should think of the two together and a combination of the two, which will produce as small a surface area as is practicable. In other words, a fine sand below a $\frac{1}{4}$-in., mix one part with two parts of pebbles, will not give

as good a concrete as a coarse sand below a ¼-in. sieve, mixed one part to two parts pebbles.

This suggests the thought that the division between sand and gravel on the ¼-in. sieve is not the fundamental thing, and that we should think of our aggregate as a whole or combined sand and gravel.

Another thought may be introduced here, namely, that we need a certain amount of fine material in the concretes, otherwise they become harsh and unworkable and the concrete does not hold together on the job, but separates when it is being placed.

Production of Aggregates.

The aggregate industry has been divided into special interests, as crushed stone, sand and gravel, and slag. There is a tendency to combine these interests into one organization called the Mineral Aggregate Organization. Surely this would lead to the establishment of research which would settle some of these mooted questions.

The production of sand and gravel aggregates is of special interest to people in Indiana, where there is such an excellent quality of material. This industry industry has its own particular problems, some of which may be suggested.

1. Is it possible to produce a plant mixed aggregate, that is instead of shipping sand and pebbles separately, to ship the proper admixture of sand and pebbles to suit the sizes as found in the deposit? There would be certain advantages, as saving in the storage space, which is particularly valuable in large cities. Of course, the method of handling on the job must be such as to avoid a re-separation of the material.

2. The conservation of our sand and gravel material through intelligent use. Abrams has shown us that there may be quite a wide variation in the curve of sizings without substantial change in strength. We have found at Purdue University that as much as 15 per cent of the coarse sand may be allowed to pass over into the fine aggregate without changing the strength substantially. With a 15 per cent tolerance in the coarse aggregate below the ¼-in. sieve the production of cars per day would be increased up to 50 per cent in some cases and the waste of a large amount of valuable coarse sand would be prevented. Indeed some deposits may be divided into sand and gravel on the ⅛-in. screen and used 1-2-4.

3. The standardization of sizings and gradings of sands for various purposes, such as concrete sand, engine sand, plaster sand, sand for waterproof mixtures, for wearing surfaces, etc.

4. There is a tendency now to rule out gravel from, or require special protection in, fireproof structures on account of the supposed spalling qualities. This question demands further investigation.

5. The development of a proper test for hardness of gravels. At Purdue University a promising test has been developed, but it is too early to decide its usefulness.

Sieves should also be standardized. In our laboratory we use two sets of sieves, the so-called Tyler sieves, and the sieves specified by the United States Bureau of Roads. There is a third standard being urged by the United States Bureau of Standards. There, of course, should be only one scale of sieves to apply to specifications for grading of aggregates.

The question of the value of slag for an aggregate for concrete is still under discussion. It is agreed that this material may make an excellent aggregate, producing a hard, light and good wearing concrete, and that it is available where other suitable aggregates can not be found. The methods by which specifications can assure a chemically inert aggregate are not as yet determined.

In spite of the arguments of those who advocate the use of integral waterproofing mixtures, engineers and investigators are doubtful of their expediency. In fact the whole subject of waterproofing concrete is yet to be placed on a firm scientific basis. Methods formerly considered standard, as by the use of membranes, are being cast aside in the latest practice.

VI. Metal Reinforcement.

Standard specifications now permit both Billet steel and re-rolled rail steel. Some engineers are advocating strongly specifications for only one grade of reinforcing bars, namely, the intermediate grade rolled from open hearth Billet. Here it is again a question of the use of available supplies, and there is a danger of specifying an ideal product, which may not be available and which is unnecessarily high quality for the job in hand. The technical question of planing deformed bars to uniform sections for test is up for discussion.

We may say in general that the present movements are in the direction of changing ironclad and traditional specifications with more flexible provisions, whereby

the producers and engineers are allowed to obtain the desired results by variation in the mix or aggregate. This must be so in the case of concrete where the available aggregates in the various parts of the United States should be used to the best advantage, saving transportation and other expense.

VII. *Consistency.*

Since it is realized that concrete should be mixed with as small amount of water as will yield the proper workability or mobility, it is important to devise some measure for this property. Professor Abrams devised the slump test in which a cylinder of fresh concrete was allowed to deform. The measure of consistency was the slump which ranged from ¼ to 8 ins. for the various kinds of concrete. An improvement on this test was the substitution of a truncated cone for the cylinder. Still further improvement is the use of the Bureau of Standards' flow table. The truncated cone is placed on a circular table, which, through the medium of a crank shaft and cam, is lifted up and dropped ½-in. 15 times. The truncated cone gradually enlarges to a flatter mass. This later test is not so available for field use as it is for laboratory use, but it gives very nearly a straight relation between water-cement ratio and consistency. One improvement in control is to pre-wet aggregates in the stock pile.

VIII. *Mixing of Concrete.*

After all scientific research has fixed the proportion of mixture and the qualities of the materials, the concrete must be mixed and mainly in a batch mixer. The action of the mixer involves, first the hydration of the cement and the thorough mixing together of the greatest consistency in the concrete. Different mixers are designed to bring about different sequences of movements in the drum. Some have a sort of churning action in which the material moves outward and inward through the shape of the drum or by the action of deflecting blades. In other types material is lifted up by buckets and dropped, sometimes returning by the action of a chute to the inlet of the drum.

Specifications will define the minimum time of mixing from 2 minutes to 1 minute.

Recent improvements in mixers provide a device for measuring the amount of water in the batch and limiting this amount, and also providing a locking device, which prevents the operator from discharging the batch until the minimum time has elapsed.

The most thorough researches point to the fact that with improved mixers there is very little increase in the quality of the concrete after 1 minute of mixing. In large jobs concrete is mixed at central plants and transported several miles in trucks to the place of deposit. The method of handling such concrete and the consistency, etc., are yet to be determined.

The practice of chuting or spouting concrete from towers for long distances is common. Such concrete is likely to be too fluid and tests of such chuted concrete have shown strength of about 1,000 lbs. per sq. in., whereas the engineer expects 2,000 lbs. per sq. in. Certainly the angle of the spout should be such as to allow the concrete to flow without a separation of the ingredients, and this should limit the angle of the spout with the horizontal. This subject also needs investigation.

IX. *Methods of Depositing Concrete in Cold Weather.*

It is now a common practice to construct concrete buildings without regard to exterior temperatures, but the danger is in the use of too fluid a concrete, mixed with either an aggregate or water that is too hot, resulting in the shrinkage cracks and poor concrete. An accepted method is to heat the aggregate by allowing live steam to come out of a perforated pipe. Merely throwing the aggregate on the sheet metal under which a fire is maintained is defective practice. Sometimes a gasoline torch is turned into the concrete mixer.

Probably the latest improvement in mixing and placing concrete consists in holding the consistency and the amount of water to a minimum. Around New York, where contractors used to feel it necessary to put in sloppy concrete, they have been taught by engineers to put successfully concrete with ½-in. slump. Thorough mixing and depositing with adequate slicing and working results in a solid concrete of high strength.

The action of sea water on concrete is a subject of controversy and we must wait for the final word on this subject. Structures in sea water seem to be unaffected when the concrete is dense and the outside skin of the carbonated cement is kept intact. Where abrasion through ice and floating objects wear away this skin the sea water certainly does eat into the concrete. In many situations designers, therefore, protect

the concrete between tidal levels by some protecting stone or other material.

X. *Expansion Joints.*

Just when expansion joints must be placed in long buildings is a subject of debate. The shape of the building enters into this question. A long narrow building would require expansion joints, where a square building of the same length will not. Structures exceeding 200 ft. in length and of a width less than about one-half of the length should, no doubt, have expansion joints not over 200 ft. apart to minimize the effects of temperature changes and shrinkage.

XI. *Fireproofing.*

There is probably no material which is not damaged to some extent by severe fires, and, realizing this, the regulations for fireproofing buildings are becoming more strict. The difference of requirement is made according to the character of the aggregate. Where the mortar and the coarse aggregate have different expansion coefficients some other protection, such as plaster on a metal mesh is specified.

XII. *Investigations.*

The most fruitful investigations have been those coming from the Structural Materials Laboratory of the Portland Cement Association, conducted in cooperation with the Lewis Institute, under direction of Professor Duff A. Abrams. The bulletins from this laboratory must be read by all those who wish to be informed of the latest knowledge on proportioning concrete and the effect of various elements upon its strength.

Investigations, which should be continued, include: The control of the spouting process so as to assure good concrete; the possibilities of central mixing plants; the use of hydrated lime and other powdered admixtures; continuation of the investigation of sizings of aggregates; development of field tests and convenient and cheap molds for specimens; the technical merits of various grades of reinforcing steel; the use of salt water in concrete of various grades; the strength of a concrete which may be reasonably expected in construction, a standard field method for determining consistency of concrete, investigations to prove the efficiency of concrete mixers.

The whole question of design of concrete road surfaces in respect to the varying values of the soil, the effects of loading, of impact, etc., is a field that has been worked upon but very little.

Some investigations should also be made of the design of a deformed bar, and specifications arranged to define those bars which are of sound design and of practical manufacture.

XIII. *Design.*

One of the mooted questions is the portion of bending moment which should be figured in columns. This is arrived at largely by theoretical considerations, and should result in the specification of the per cent of bending moment in the floors transmitting to the interior next to the columns. At present the specifications are vague.

The working stresses on reinforced concrete columns allowed by the New York building laws are much in excess of those permitted by the old Joint Committee report. This partly arises from the limitations in the old Joint Committee report of the amount of spiral steel that is counted upon as contributing to the strength of the columns. There is a tendency to increase to 2 per cent the amount of spiral reinforcement that is figured as contributing to the calculated strength of the column. A total of 6 per cent in the lateral and longitudinal reinforcement is sometimes used. The amount of stress to be figured in this lateral reinforcement and the quality are matters of discussion.

A subject of practical as well as theoretical interest is the implications on column design of the well known property of plasticity exhibited in concrete. That is to say concrete, under working loads, deforms slowly without increase of stress. This necessarily relieves the stress in concrete and increases the stress in the steel. The same condition will, of course, hold for slabs and beams. The logical treatment of this condition is wanting.

The increase in bond stresses, where steel is bent over or hooked at the ends is also to be considered.

Experiences of the United States Shipping Board and the tests in various laboratories lead many designers to recommend largely increased shearing stresses in properly reinforced concrete beams.

All of these matters, which are based upon laboratory experiments, have been, in the past, judged upon a very conservative basis. Specifications rest upon the state of the art and must provide for poor inspection and faulty manufacture.

Recent tests of concrete cylinders bored out in the shape of cores from constructions show a strength in concrete much larger than we had expected, up to 6,000 lbs. per sq. in. On the other hand other

specimens on other jobs are low in strength. It is probable that laboratory tests are some where between poorly made concrete and the best field manufactured concrete.

Our regulations and building laws should certainly recognize the progress of the art, but in the interests of safety we should not go beyond the point where the necessary control is to be provided in construction. While concrete of 6,000 lbs. strength can be found in concrete roads, concrete of only 900 lbs. strength has been found in some spouted jobs. The engineer expects 2,000 lbs. The best construction companies would, no doubt, supply a better grade.

SPECIFIC DUTIES OF THE HIGHWAY ENGINEER AND CONTRACTOR

By W. A. Rogers, President Bates & Rogers Construction Co., Civil Engineers and Contractors, 37 W. Van Buren St., Chicago.

(Editor's Note: This very fair and thoughtful summary of the chief duties and responsibilities of the highway engineer and of the highway contractor is from a paper by Mr. Rogers before the American Road Builders' Association. It deserves close attention.)

The Engineer's Job.

Theoretically the engineer is the representative of the contractor as well as of the State, for the contract generally names the engineer the sole, unbiased arbitrator between the parties of the contract, with power to decide finally many matters arising under the contract. This places the responsibility on the engineer of deciding what is right and fair in matters at issue between the parties to the contract, and also the responsibility of interpreting the terms of the contract and specifications, which he or some other engineer has prepared.

Definite Specifications.

In preparation of the plans and specifications a long step towards harmonious and satisfactory relations will be made if the engineer has clearly in mind the structure to be built and describes it clearly and definitely in the specifications, leaving out all terms like "the work shall be done to the satisfaction of the engineer, etc." The contractor is entitled to have described in the specifications just what is wanted and can be followed. In a word, they should be reasonable. Incorporating in specifications, clauses which are practically impossible of fulfillment with the thought that better work will be secured by fixing up almost impossible standards is less apt to secure this result than if the specifications provide for what is reasonably possible of fulfillment.

It has been said that drastic specifications have sometimes been made for highway work with the laudable purpose of scaring away unsatisfactory and irresponsible contractors and putting into the hands of the engineer requirements which could be used to advantage in the case of irresponsible contractors, and on the other hand, could be eased up for those contractors who were doing satisfactory work. This is entirely wrong. It has just the opposite effect. When a specification is drawn, which in any respect is not workable, it casts a cloud on the entire document and the responsible contractor feels as though he were being placed in a position where an irresponsible inspector or engineer might cause him serious trouble and expense. It is, therefore, in the interest of the State and the duty of the engineer to prepare workable specifications, which can be carried out with the materials reasonably available and with the human labor which we have.

The highways of the country are not built under laboratory conditions and specifications and plans for highway work, which are prepared with the idea the subgrade can be sandpapered and the materials and water entering into the concrete can be measured as in a laboratory are not productive of the best work, but are productive of friction between the engineers and contractors and expense to both parties to the contract.

Should State Furnish Materials?

Contracts and specifications should be very definite and clear in the placing of responsibilities. In this connection I have a strong feeling that the furnishing of materials by the State is both wrong in principle and not productive of the best results, either as to harmony between the parties or as to decreased cost. It injects into the work a question of divided responsibility. It makes the State responsible for something which is part of the construction and on which the progress and economical operation of the work is vitally dependent. If the materials are not delivered in the order and at the rate which the work requires it adds to the cost, and the engineer who is not paying the bills can hardly appreciate this as does the contractor who is.

I know there is a feeling that the State

can frequently buy materials more cheaply than the contractor, and that it is able to allocate a restricted supply better than the individual contractors buying at random can do. This may be so, but I have a feeling that the competent contractor can ordinarily buy as close or closer, and he can surely control the delivery more nearly as the work requires than the State. At least he thinks he can, and that goes a long way toward making for harmonious relationship.

If, however, the engineer does specify that the State shall furnish any of the materials, then the State should assume the full responsibility for delivery. If the State fails to deliver its materials as required by the work, thus adding to the cost of the work to the contractor, then in the interest of fairness and satisfactory relationship they should assume the responsibility for such failure. Placing on the contractor a risk over which he has no control is just adding another "gamble" to a game which is hazardous fications should be so drawn that they enough without it. Contracts and specifare as free as possible from risks of this kind, in the interests of both parties.

Proper Supervision.

Supervision of the work is another duty of the engineer. This is a great responsibility and should be delegated in the field only to men of good judgment and experience. Inexperienced, incompetent field supervision causes delay to both the State and contractor and increases expense at the time to the contractor and eventually to the State.

Bear in mind that the data on which a contractor of experience bases his price which he bids on any job is the cost of previous work of similar character interpreted in the light of the conditions of the work on which he is figuring. In his previous costs are reflected the cost of not only every onerous clause in the specifications, but also the results of unfair and incompetent engineering supervision. It is, therefore, necessary and desirable that engineers in charge of highway work should be thoroughly competent. Competent engineers are entitled to compensation proportionate to their skill and experience. It is mistaken economy to save on highway engineers, salaries. Well paid, experienced engineers are conducive to the best and most economical highway work.

There is no class of contract work which requires for its satisfactory handling, such continuous operation. In order to be profitable there must be a constant uniform flow of materials from the point of manufacture or origin through the railroads to the unloading plant and then from the unloading plant to the mixer. Anything which tends to vary this uniform flow, adds to the expense of the work. The engineer, who, without proper cause, stops the work, robs the contractor just as much as the highway man who holds a pistol to your head and causes you to deliver your money. But an experienced, competent engineer will not do this.

A Spirit of Accommodation.

The highway engineer should be a very broad man. He should have in mind that his job is to get as much highway built of the quality desired as can be built and at as low a cost as possible to the contractor. Materials, especially sand, gravel and broken stone, are products of nature. They are not built in a factory to a certain standard. They may be graded by human care, but there is bound to be a certain variation. It seems to me it is the duty of the engineer to conform as closely to the specifications as possible, but bearing in mind always the final result, that his job is to get roads built of a good quality, and that if, by slight variation in requirements of qualities of material, the same result can be obtained, he should be big enough and broad enough to meet the situation. He will realize that nature does not form the sand and gravel to fit an exact laboratory standard and that it may be necessary at times to conform to what may be reasonably obtained. This means that he will use his broad judgment and good sense in the acceptance and rejection of materials.

Similarly with inspection of the work, it is sometimes the tendency of the younger engineers to forget that it is the final result which counts and concentrate on the minor details. In other words, compliance with the specifications literally is made the important item, losing sight of the fact that what is desired is the completed highway of a satisfactory quality. Variations in the construction methods or materials which give the desired finished highway will be permitted by the seasoned engineer.

Fair and Quick Decisions.

It should be one of the duties of the engineer to make fair, quick and responsible decisions. Delayed decisions are often as unfortunate as wrong decisions. By responsible decisions I mean that the State, acting through the engineer, should be responsible for his acts as the con-

tractor is for his. The contractor pays for his errors directly, in increased costs. If through error or otherwise the State causes the contractor's work to cost more than it should, they should assume their fair responsibility financially.

Finally, decisions should be made without reference to whether they will please either the contractor or the public. In work for the public like highway work or government work it may sometimes be a temptation to consider whether a decision will meet with favor of the public or not and thus have a bearing on tenure of office. The position of the highway engineer should be made free from influence of this character. And let me repeat "The engineer should always bear in mind that he is in the dual position of representing both the State and the contractor."

The Contractor's Job.

As I now turn to the description of what the successful highway contractor must do I wonder that any contractor can ever qualify. The contractor for highway work undertakes to determine the best source of supply for materials which will meet the requirements of the specifications. He undertakes to see that the producers of these materials furnish them promptly and deliver them in the required amounts at stated times necessary for the work, to the railroad for transportation to the station nearest the work. He undertakes also to see that the railroad does deliver the material promptly to his unloading point. If either of these agencies fails to do its part it costs him money and time. After delivery to his unloading point, he then must unload, store, protect and then transport these materials to the site where they are to be incorporated in the finished road.

In addition he has contracted to employ a competent force, working under the direction of a competent superintendent, with the right sort of an organization. In the case of the contractor, errors in his judgment or of any of his organization, or lack of skill or ability are paid for in real money which shows up in increased cost.

He has also contracted to furnish an adequate and properly equipped plant for the proper handling of the work. Each job should be studied carefully and planted properly. Whether the delivery of materials shall be by truck or by industrial plant should be settled. The method adopted for unloading and storing materials is a very large and important item and the success or failure of the work is dependent, to a large degree, on the plant and equipment adopted. He must provide an adequate and satisfactory supply of water. Then he must co-ordinate all of the different elements, consisting of materials, water supply and an efficient crew to build the finished highway on a subgrade, finished to an exact surface. He must then see that it is properly protected and properly cured. As though this were not enough he must act as a policeman and see that the public, who are eager to use the new road, and can see no reason why they can not, are restrained from so doing. Sometimes when I think what the ordinary highway contractor undertakes to do, I wonder at his assumption of almost supernatural powers when he signs his contract and assumes the duty of furnishing the State a satisfactorily completed job, meeting all of the clauses in the specifications as near as is humanly possible.

Honesty Essential to Success.

Above all the contractor's organization should be made up of men who are willing to meet the engineers half way and who take a pride in the quality of their work, and who are anxious to give the State an honest job. Only in this way can the highway contractor be successful. If the engineers and contractors conform to the foregoing there will be co-operation between them. There will be a realization that they are partners in a great enterprise and that the best results can only be obtained by pulling together.

As a futherance of this spirit of co-operation the formation of organizations of highway contractors, both locally and nationally, should be encouraged. In this way may be obtained responsible bodies to whom similar organizations of highway officials and engineers may turn for assistance in obtaining the viewpoint of the man who builds the highways. The meeting of committees of the contractors' organizations with similar committees of the highway engineers will tend to free the contracts and specifications from clauses which are productive of ill feeling and increased cost, without adequate return in better quality.

Co-operation Between Engineers and Contractors.

This very thing is being done with advantage to both parties in other lines of construction work. Committees of the Associated General Contractors of America are meeting with committees of architects and engineers to "thrash" out ques-

tions of contracts and specifications and conditions of work, with the certain final result that mutually satisfactory contracts and specifications always result in a lower price to the owner and more satisfactory profit to the contractor.

In some states conferences have been held already between highway officials and engineers and contractors' committees, with the object of making the contracts more workable and with excellent results. I feel that this ought to be done in every state. I also feel, through such meetings between the national bodies, a standard form of highway contract should be formulated to be varied from according to local conditions. With such a standard form of contract, which is absolutely fair to both parties, we will get the most good roads built with the least money spent by the public.

SOLVING THE HIGHWAY BRIDGE PROBLEM IN NEW JERSEY

By Charles A. Mead, Bridge Engineer, New Jersey State Highway Commission, 790 Broad St., Newark, N. J.

(Editor's Note:—Because of highway transportation across New Jersey, particularly between the cities of Philadelphia and New York, the highway bridge problem in that State is such that structures of the best type must now be built. Mr. Mead here describes the present bridge engineering practice in New Jersey in a paper presented at the 1921 meeting of the New Jersey Association of County Engineers.)

It is the intention of this paper to dwell on some of the salient features in the design of bridges for New Jersey highways and the reasons for the construction adopted, in the hope that there may be produced structures of greater uniformity, adequate to meet all demands of traffic for years to come.

The State owns at present 704.2 miles of highways on which exist 568 bridges of over 5 ft. span. They comprise timber, masonry and metal structures of various kinds, lacking in uniformity of specification and condition, but all of which are called upon to support the traffic which the development of the internal combustion engine has thrust upon them.

80 Per Cent. of the Bridges Are Obsolete

It is not the intention of this paper to criticise the design of a generation ago, when a farm wagon or a load of hay was considered a heavy load. That bridges which were well designed for the loading of a by-gone day still give service shows in a measure what may be expected of those now building, for a well-designed bridge will carry a large percentage of occasional overload without distress. Today, however, 80 per cent. of the existing bridges in this State are incapable of meeting the demands of modern traffic.

When the State assumed control of the highway system last year several very important bridges were on the verge of failure, two of the more recently constructed ones had actually collapsed, and others needed immediate attention in various ways to keep them in service until major repairs or rebuilding could be reached. This repair work has proceeded along with the preparation of plans for the new structures designed for modern loading.

The Loading Adopted

After a careful study of the various truck loadings actually in service and the tendencies of the times, both from a military and commercial point of view, a loading was adopted, commonly referred to as a 20-ton truck, which would produce bridges adequate for the demands of modern traffic and provide for such increases as are sure to come. The loading, therefore, is not so much a typical truck as a live loading which will produce serviceable bridges.

The geographical location of New Jersey between the two great commonwealths of New York and Pennsylvania makes it imperative that her structures shall be of the best.

Restrictive legislation, to be permanent, must be in accord with the demands of commerce. Growth far beyond the vision of traffic experts in every other mode of transportation has been experienced and highways will prove no exception to the rule.

The number of miles of road per bridge varies considerably, from one-half on Route 16 to 8 1/10 on Route 14. By far the greater number are located in the north. Roughly, 60 per cent. lie in the northern part, 29 per cent. in the central, and but 11 per cent. in the southern part of the State.

In the northern part of the State the deeper cut streams which have found their ultimate bed have more definitely fixed profiles, which give less latitude for span length and skew than in the southern part, where these conditions are reversed. Destructive floods are consequently more frequent in the northern parts.

Waterway Areas

It is to be regretted that no adequate

financial provision has been made in New Jersey for a comprehensive system of stream gaging, the data obtained from which through a period of years would be increasingly valuable and useful in many ways for economic development of the State.

Each bridge site receives study to determine the proper area of waterway. Existing openings are noted, shape and size of drainage areas determined, and estimates are made of rainfall and run-off. These data are checked by the Talbot formula and the desired area of waterway determined. This procedure is facilitated by the existence of a complete and accurate topographic map of the State which eliminates much survey work and greatly reduces the cost of preliminary investigation. Sub-soil conditions are studied at pier and abutment locations and foundations designed in accordance with the findings.

Conditions Governing Types

Deck bridges being the most economical in first cost and maintenance, are to be preferred wherever the conditions are favorable. Long spans and low headroom often compel the use of through or half-through bridges. Of these the most economical is the plate girder. Beyond the limits for plate girders the more elaborate lattice girder must be used, giving preference in all cases to riveted over pin connections because of the greater rigidity possible. For spans up to 20 ft. reinforced concrete slabs are to be preferred. Encased I-beams may be used up to 30 ft. Beyond that, built-up sections must be resorted to. Transportation limitations must be considered as a material factor in design.

Concrete being a durable structural material of low cost and diversified application, finds almost universal use in the modern bridge. Used in mass work for substructure and in combination with reinforcing steel for superstructure parts subject to transverse bending it forms an ideal material for permanent structures. Even though its properties are so universally known and appreciated it requires careful and honest workmanship and good design to produce enduring results. Walls may be either of gravity monolithic or reinforced slab types. The resultant line of pressure should be carefully determined so that toe pressures will not exceed the maximum allowable or movement perhaps fatal to the structure will result. They should be self sustaining under all conditions of loading and have adequate provision for expansion.

Foundations

Their footings should be set at a depth which will insure them against damage from frost or scour. In streams which have found their ultimate bed from 4 to 6 ft. below the stream bottom will be sufficient. In material incapable of supporting the required loads without unduly spreading the footings some other means must be used to carry the loads to a substratum which will provide adequate supporting power. For moderate depths with fairly compact intermediate strata so confined as to remain undisturbed, piles of wood or other material will be found most suitable. Wooden piles will usually be found most economical provided they can be cut off below low water line. For deeper foundations of major importance it will be necesary to use the more expensive but reliable open coffer-dam or pneumatic caison types. Happily the necessity for these more expensive substructures exists at few locations.

Drainage and Culverts

Proper attention should always be given to drainage. With weep holes provided in walls and the entrances to these holes properly guarded by rip-rap or French drains the back pressure from hydraulic heads will be reduced so that the theory of earth pressure will be realized.

Cast iron or reinforced concrete pipe of proper design and having proper headwalls will usually be found economical for openings of less than 40 sq. ft. For larger areas culverts should be used. They may be single or multiple monolithic arches or reinforced concrete slabs. If boxes of reinforced concrete are used the bottom slab should have the same care in the arrangement of reinforcing material as any other part of the structure for the load carried is equal to that on the top slab.

Waterproofing

Owing to the difficulty of making concrete entirely watertight and as water is almost a universal solvent, it is of the utmost importance that the entrance of water to any part of a structure be prevented. This is especially true of parts not accessible to inspection. Paint on metal work is effective on parts exposed to air which aids in the rapid removal of moisture. Structures should be so designed that all possible parts can be readily inspected. In the case of inaccessible parts, such as embedded steel, if reached by moisture, changes will occur and may progress with surprising rapidity especially if electrolytic action is present. Where there is no actual leaking,

the presence of water will be indicated by surface staining, indications of leaching and spalling most strongly marked at joints or pour lines. The formation of rust scale on imperfectly embedded steel sets up great pressures, recorded as high as 4,700 lbs. per sq. in., which will destroy the bond and eventually menace the safety of the structure. Water should therefore be conducted away from the bridge as rapidly as possible by providing drainage grades in every part. Inaccessible parts should be protected by waterproofing which is cheap insurance. With waterproofing cost at 2% of the cost of the structure and money at 4% it is evident that if waterproofing prolongs the life of the bridge 6 months it pays to do it.

Floors

In regard to the construction of floors—because of under-clearances and reduction of dead load, it is generally desirable to produce the thinnest floor consistent with good design. This can be accomplished by carrying the live load directly on the floor slab after providing a small extra thickness of concrete cast integrally with the slab for wearing surface. Otherwise to protect the slab from wear, the entire surface may be covered with some bituminous compound applied in a plastic condition or with paving blocks of wood or other material. The latter making a slightly thicker floor than the former.

The width adopted is 30 ft. between curbs for all new bridges and sidewalks and to be provided where required.

The distribution of local concentrations on slabs is a subject which is being intensively studied from meager data resulting from destructive tests. The tendency is slightly to reduce the slab thickness from the old assumptions of distribution wherein the load was distributed at 45 degrees in each direction to the plane of reinforcement, resulting in a somewhat lighter and cheaper bridge. Further tests are however needed in order fully to cover this subject.

Where floor thickness is not a material factor, conditions more nearly approaching ideal may be realized in small spans by locating the slab low enough to permit the road construction to be carried continuously over the bridge. In any case the road paving on the bridge should extend continuously from curb to curb.

Slab floor bridges of short spans on solid supports will usually be found stiff enough to provide for lateral, longitudinal and centrifugal forces. The necessity for adequate bracing in all directions should never be lost sight of to the end that the resulting structure be rigid under all conditions. Unless a bridge can be used as unrestrictedly as the highway it connects, it is not an adequate bridge.

Bridge Railings

Bridge railings to afford necessary protection should be designed capable of withstanding the impact from unmanageable vehicles of the weights specified. A monolithic concrete railing well reinforced will be found adequate. Such a railing is not an extravagance as it can be produced at a cost about equal to a heavy galvanized pipe railing and is vastly superior to it in strength, endurance and appearance. It is the practice to mold the State's name, Route number and year of erection in these railings.

The only impression gained of a bridge by the traveling public is that attained by the appearance of the railings. These should leave in their minds the pleasant sensations of safety and harmony.

Aesthetics

There seems to be a widespread notion that arches are beautiful. Some are. Being predicated on immovable abutments they should never be used in flat marshy country where there is the slightest question of security concerning the founding material. Simple spans giving vertical reactions can be made attractive in appearance and when they are in harmony with their surroundings and express a structural necessity they are pleasing.

Good design requires an arrangement or grouping of parts so that the eye is led to consider the structure as a whole rather than an accumulation of unrelated pieces which lack interest because of their incongruity. It need not cost any more to produce structures which are pleasing to the eye than those which are displeasing. The matter of aesthetics is therefore of great importance.

Viaducts being simply a succession of connected simple structures are subject to the same laws as simple spans. Especial attention should be given to their supports providing the rigid bracing and anchorage required.

Movable spans are often required over navigable streams. Their design should follow the principles herein outlined, the particular type being selected for its fitness in the location.

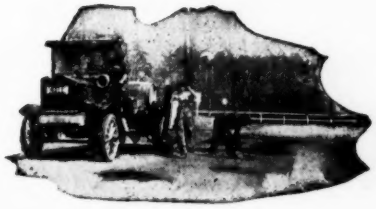
Limitations of Standardization

Questions are often asked concerning bridge standards and requests are frequently made for them. This work can easily be over systematized. It is possible to standardize certain structural parts of

President Harding *Urges* Road Maintenance. *He says—*

"I KNOW of nothing more shocking than the millions of public funds wasted in improved highways, wasted because there is no policy of maintenance. The neglect is not universal, but it is very near it. There is nothing the Congress can do more effectively to end this shocking waste than condition all Federal Aid on provisions for maintenance. Highways, no matter how generous the outlay for construction, cannot be maintained without patrol and constant repairs."

EXTRACT FROM FIRST MESSAGE
TO CONGRESS, WASHINGTON, D. C.
APRIL 12, 1921



Road patrol maintenance crew patching improved road with "Tarvia-KP"

Tarvia
For Road Construction Maintenance and Repair

New York Chicago Philadelphia Boston
Detroit New Orleans Birmingham Kansas City
Salt Lake City Seattle Peoria Atlanta
Johnstown Lebanon Youngstown Toledo
Elizabeth Buffalo Baltimore Omaha

The Barrett Company

St Louis Cleveland Cincinnati Pittsburgh
Minneapolis Dallas Nashville Syracuse
Duluth Milwaukee Bangor Washington
Columbus Richmond Latrobe Bethlehem
Jacksonville Houston Denver

THE BARRETT COMPANY, Limited: Montreal Toronto Winnipeg Vancouver St. John, N. B. Halifax, N. S.

bridge such as decks, abutments, walls, floors and railings and this has been done. It is not practical to standardize the assembly of those parts because it is very rare to find two physiographic locations where exactly the same structure will fit —hence the term "standard" as applied to complete bridges is a misnomer.

Wooden bridges or trestles may be proper in some locations notwithstanding their inflammability. With timber properly treated to resist decay and the destructive attack of the various marine borers, a properly designed structure with good maintenance will give upwards of 15 years' service. These must in any event be regarded as structures of expediency, having a temporary nature, to be replaced with more permanent ones as occasion demands. Timber structures with their necessarily weak joints must have especial attention given to bracing.

Questions of economics and expediency so largely enter into this subject that only the most general principles can be stated. All things considered, that bridge which is best for a given location is the one which will provide safe and adequate service at the lowest cost and be in harmony with its surroundings. Such bridges we are endeavoring to construct.

FEATURES OF ANNUAL ASPHALT CONVENTION

The second annual convention of The Asphalt Association was held at the Association headquarters in New York, April 13.

The annual address of the president, Joseph R. Draney, of the United States Asphalt Refining Co., New York, developed the need of many men for work during the highway construction period now opening. Mr. Draney reported that the asphalt industry, on the whole and despite present conditions, is in a sound condition with prospects for the production of enough oil to assure an adequate supply of asphalt for years to come.

Work for One Million Men

President Draney predicted that, unless reactionary pessimism grips the nation, 700,000 men wil be needed in the building of the 35,000 miles of new highways contemplated this year under the billion dollar road program outlined by the Federal government and the states and counties. Three hundred thousand more men, he said, will be needed in the quarries, gravel-pits, cement, brick and asphalt plants and factories devoted to the manufacture of road machinery. The road-building boom, he thought, will work great benefit to the railroads by bringing into service 100,000 idle freight cars to transport 100,000,000 tons of road materials.

"To set a great army of 1,000,000 men, now for the most part unemployed," said President Draney, "at building highways is to solve in part not only the acute unemployment problem facing the nation but also part of the rail troubles. Furthermore, money in plentiful quantities would be released for local circulation through wages to local labor and in payments to local producers of stone, gravel, sand and other materials, thus easing the pressure brought about by the reductions in the price and demand for agricultural products. Stimulation in the production of trucks, machinery and raw materials, and in engineering, and the employment of labor can positively be accomplished with an untrammeled road-building program. At the same time we would be reducing the dangers to travel by abolishing railroad grade crossings, more adequately bridging rivers and smaller streams, putting the outlying districts closer to medical and hospital aid and would bring the farmer and his market in closer touch."

Resolutions Adopted

1. Urging Congress to pass the Federal aid appropriation of $100,000,000, thus assuring a continuance of road-building under the supervision of skilled state and federal engineers.

2. Urging that highway management be divorced from politics and all materials and methods entering into highway construction be placed in open competition.

3. Declaring that every highway be required to show traffic justification for its construction, thus guarding against waste and extravagance.

4. Memorializing Congress to authorize the United States to join the Permanent International Association of Road Congresses made up of the highway departments of all nations.

5. Urging the Interstate Commerce Commission to authorize a reduction in freight rates for road materials, thus stimulating the road-building program.

6. Recommending that public officials carry forward road-building programs to the extent permitted by appropriations available, thus giving employment to many hundred thousand men now out of work and utilizing tens of thousands of idle open ton freight cars.

WATER WORKS SECTION

CAPACITY CHARACTERISTICS OF A DEEP WELL

By Lawrence W. Cox, Consulting Engineer, 1102 York St., Des Moines, Iowa

Due to their limited financial resources, a large portion of the towns in the State of Iowa, particularly the southern part of the State, find it difficult to secure sufficient water for public supplies. Hence it becomes essential to make the best use possible of such supplies as can be secured. Assuming that the supply of water is usable but scanty (which is the ordinary case), a careful determination of the capacity of the well with the corresponding depression of the water level in it, should be made. Then the supply may be well utilized by the installation of suitable pumping equipment.

Apparatus for Determining Depth to Water Surface in Drilled Well

During pumping tests the action of open dug wells can be easily watched, but with drilled wells the condition is very different. For the purpose of more carefully watching the action of drilled wells during pumping tests, the writer in 1915 developed an apparatus for the purpose of determining the depth to the surface of the water in the well at any time. This apparatus consists of a ½-in. galvanized iron pipe about 18-in. long, with a wood float inside. This pipe is suspended between the drop pipe of the pump and the well casing by means of two insulated wires, such as ordinary drop cords for use in wiring houses. Contact points are so arranged that when the pipe enters the water and the wood float lifts to its upper position, the two wires are brought into contact with each other. There are several ways by which this contact may be made, but the writer has found the method shown on the accompanying figure to be the easiest made and the most reliable. Another method would be to bring each wire to a separate light spring, across the top of the pipe. Then when the float lifts, it could push the springs together and thereby make contact. For current, from two to four ordinary dry cells are used. To assist in reading the depth to water, graduation marks are made upon the suspending wires. If these graduations are placed every 10 ft. the intermediate distances can be measured by a steel tape or by a foot rule.

The suspending wire is reeled on a spool, each wire being attached to a separate circular contact at the end of the spool. The spool is placed in a box which carries two corresponding contacts, so that as the wire is reeled either in or out, contact is continuously made with the batteries and lamp, which are placed in the box behind the reel of wire. An electric bell or buzzer can be substituted for the lamp, but the writer has found the lamp the more satisfactory.

The transmitter (½-in. pipe, with its float, etc.) as now made, and as shown on the accompanying figure, has a maximum outside diameter of 1⅛ ins., but this dimension can be cut down to ⅞ in. if necessary. The present apparatus has been used in a well with not more than 2½ ins. clear space between the pump pipe and the well casing and to depths of 260 ft.

Test of Well at Prairie City, Iowa

The application of the use of this apparatus to well tests and the results obtainable by careful well tests may be illustrated in the test of a well at Prairie City, Iowa. This well was tested in the fall of 1917. It had been in use for a good many years by the city. In fact, the city had worn out one set of pumping equipment with it, while pumping water at the rate of 16 G.P.M. As the city wanted to purchase new pumping equipment with greater capacity, if the well could supply sufficient water, a test was made.

The well was cased to a depth of 97 ft. with 12-in. pipe, and from this point to a depth of 343 ft., with 10-in. pipe. Below this point the hole was in limestone and not cased, extending to 500 ft. When not pumping the water level in the well stood at 110 ft. below ground surface or 13 ft. below the lap of the 12-in. and 10-in. casing. Hence no appreciable quantity of water could be expected to enter the well above the bottom of the 10-in. casing or 343 ft. from the surface.

For the purpose of testing, a double-acting cylinder was purchased and placed on the drop pipe which was already in

the well. The old pump and engine were used in making the test runs.

Each test was made at a uniform rate of pumping and in each case the rate of pumping was carefully determined by frequent measurements of the water actually delivered.

The first test was at a rate of 32 G.P.M. and lasted 8 hours 30 minutes. Frequent measurements to the water level in the well indicated that at this time it was remaining substantially constant. Hence there was no object in continuing the test longer. Without the use of the apparatus described, we would have had no knowledge of the depth to water in the well, other than that it had not been pumped dry.

The second test was made at a rate of 44.6 G.P.M. After 25 minutes the water was lowered to the bottom of the pump pipe, when the rate of pumping dropped off to 37 G.P.M., no doubt closely indicating the capacity of the well with the water depressed to this point—that is, to 260 ft. from the surface.

The third test was made at a rate of 38.5 G.P.M. After a period of 1 hour 5 minutes, the pump broke down and the test was necessarily discontinued. Nevertheless the measurements taken indicated a curve having the same general form as that of test No. 1, and after a period of 2 hours and 30 minutes would no doubt have lowered the water to the bottom of the pump pipe.

The fourth test was made at a rate of 35 G.P.M. After a run of 50 minutes the pump again broke down, but the curve during this test was similar to and intermediate between those of tests 1 and 3.

Interpretation of Test Data

The accompanying figure shows the curves representing these various tests,

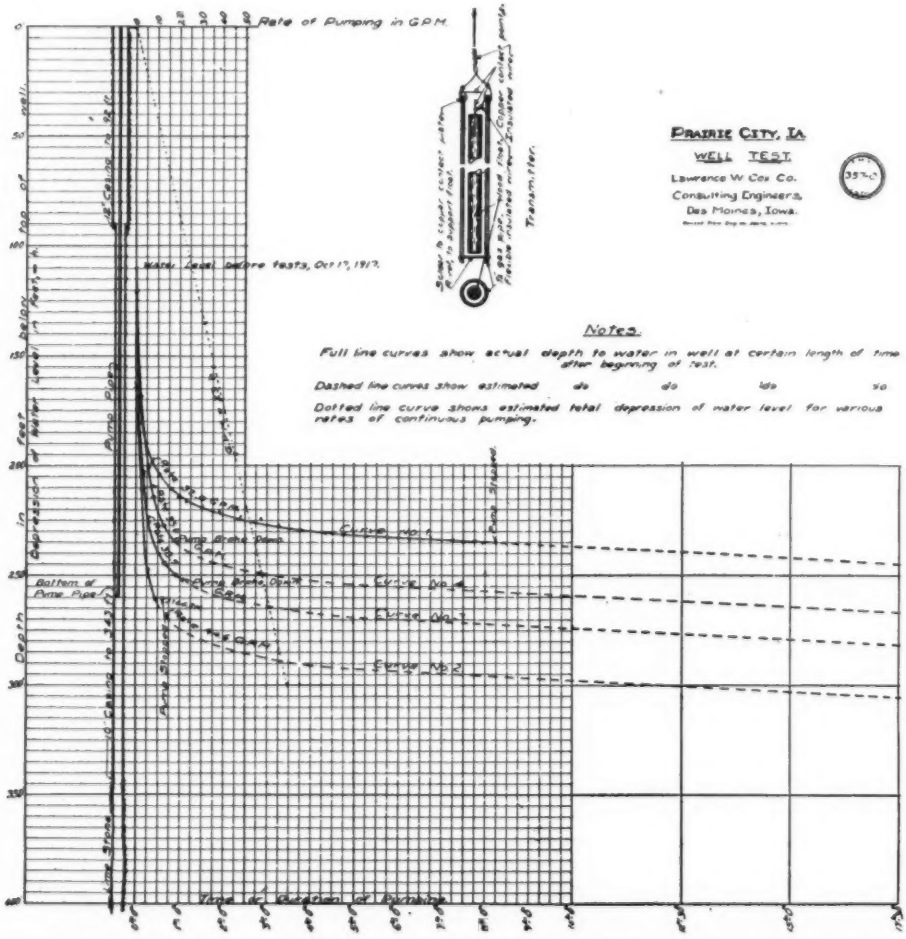

Rate of Pumping in G.P.M.
Prairie City, Ia.
Well Test
Lawrence W. Cox Co.
Consulting Engineers
Des Moines, Iowa.
Notes.
Full line curves show actual depth to water in well at certain length of time after beginning of test.
Dashed line curves show estimated do do do do
Dotted line curve shows estimated total depression of water level for various rates of continuous pumping.
Bottom of Pump Pipe
Curve No. 1
Curve No. 2
Depth in Feet of Water Level Below Pump Pipe
Time in Minutes

DIAGRAM SHOWING RESULTS OF WELL TEST AT PRAIRIE CITY, IOWA.

together with the plotted points indicating the readings taken. The first impression will probably be that the curves for tests Nos. 2, 3 and 4 have been extended far beyond the limits justified by such short time tests. Further examination, however, furnishes the following reasons for believing the curves to be substantially correct and within safe limits—that is, that the well will furnish as much or more water than indicated by them. It is probable that after a period of 8 to 9 hours, each of the curves should be horizontal instead of having the small slope shown.

1. The supply of water must enter the well below the bottom of the 10-in. casing, or below a depth of 343 ft. from the surface, or at least 233 ft. below the normal height to which the water stands in the well. Hence it is reasonable to assume that the nearer the water in the well is depressed to the bottom of the casing, the greater will be the rate of yield.

2. By actual measurements on the curve sheet, it is found that the vertical distance between any one of the curves 1, 2 and 3 and that of curve No. 1 (so far as readings were actually taken) is almost constant. Hence it seems logical to extend them at these uniform distances from curve No. 1.

3. The test represented by curve No. 4 drew the water to the bottom of the pump pipe, and, with the water held at this level, the well continued to supply 37 G.P.M. This must very nearly represent the capacity of the well with the water depressed to this point. Curve No. 4 represents a depression of the water level to this point after about 10 hours' pumping. But at this point the curve is very nearly horizontal. Hence this condition checks curve No. 4 within 2 G.P.M. or within 5 or 6 per cent.

4. It is evident that if any appreciable amount of water is drawn from the well, the water level will be depressed somewhat. Hence any curve representing the ultimate depression of the water for different rates of pumping must pass through the point of 0 rate and 0 depression of water level. Such a curve is represented on the accompanying figure by dotted lines. Next points were plotted representing the depression of water level as shown by curves 1, 2, 3 and 4, after 17½ hours' pumping. This period of time was selected because it was the greatest period of time shown on the curve sheet and because it surely represents the lowest practical point to which the water will be drawn, if the curves are reasonably correct. All of these points were found to lie substantially upon a straight line through the 0 point. The equation of this line is G.P.M.=0.23 h, where h represents the depression of the water level in feet, and G.P.M. represents the rate of pumping at a uniform rate, in gallons per minute. Actually the graph would have taken a slight curve, representing somewhat more capacity in the well, for large depressions of water level, than indicated by the straight line, but the difference would be small. Now, since this curve passes through the 0 point and through points for the curves 1 and 4, which have been well established, it furnishes good evidence that the curves representing tests 2 and 3 are also substantially correct, since their plotted points also lie on this straight-line curve. We can then determine for this well that the following rates of pumping can be relied upon within close limits:

20 G.P.M. for a draw-down of 85 ft.
30 G.P.M. for a draw-down of 130 ft.
40 G.P.M. for a draw-down of 170 ft.
50 G.P.M. for a draw-down of 215 ft.

The draw-down should, however, not be confused with the distance of the water from the surface of the ground. In this case this distance is 110 ft. greater than the draw-down.

The pumping equipment actually installed was designed for a capacity of 32 G.P.M. actual delivery, with an allowable draw-down of the water in the well of 150 ft., or to a depth of 260 ft. below the surface of the ground. This equipment has been in service since the fall of 1917 and has proven safe and satisfactory. As the demand of the town for water increases they can lower their pump pipe and install a larger cylinder, thus increasing their supply up to 50 G.P.M., but the cost of pumping against the additional head will of course be greater.

Money for Well Tests Well Spent

Numerous cases have been brought to the writer's attention where pumping equipment, not properly adapted to the wells, has been purchased and installed at great expense. Towns can not learn too soon that money spent in testing their wells is economically spent, except where the adequacy of the supply is otherwise well known, and engineers should insist upon their towns and cities having such tests made. The apparatus described for these tests can easily be made locally.

NEW REINFORCED CONCRETE COVERED RESERVOIR FOR ARKANSAS CITY, KANSAS

By R. E. McDonnell, of Burns & McDonnell, Consulting Engineers, Interstate Bldg., Kansas City, Mo.

(Editor's Note: This new reservoir at Arkansas City is the largest covered clear-water reservoir in Kansas; most Kansas reservoirs are not covered. The construction feature of raising the forms and thereby using a minimum amount of lumber is of special interest. The top of the reservoir is used for tennis courts, equipped and managed by the municipality.)

A 2,000,000-gal. concrete reservoir recently completed at Arkansas City, Kans., embodies some interesting features of design and methods of construction.

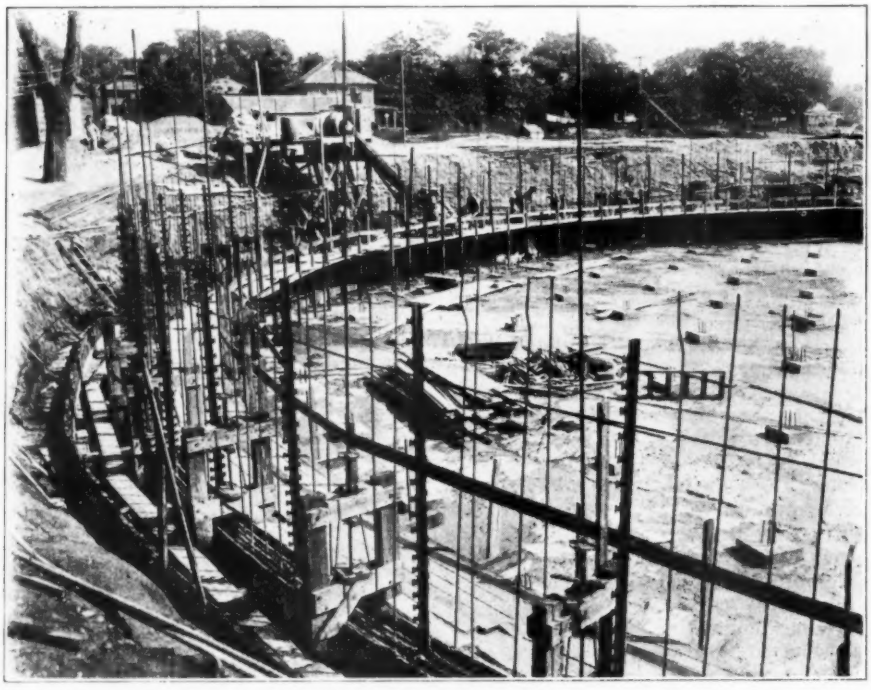
The water supply is obtained from wells equipped with motor-driven deep-well-type vertical centrifugal pumps located approximately 1¼ miles from the high-service pumping station, and is pumped through a 20-in. wood stave pipe line to the reservoir, located near the main pumping station. The reservoir provides a reserve storage for interruptions of power service, emergency demands, and allows the well pumps to operate at uniform steady rates.

Preparing the Site

The site available for the reservoir location was a low tract of ground that had been of a swampy nature and had been partially filled in with old refuse, brick, tin cans, street sweepings and rubbish. Test borings were made and the results indicated approximately an average of 8 ft. of old fill and original loam and 2 ft. of water-bearing sand overlying a solid limestone stratum, requirng 6 ft. of tight sheeting to hold lower banks. The ground water level was approximately 4 ft. above the rock surface. The rock surface was fairly smooth and level, having a grade or dip of less than 8/10 of 1 per cent. Several faults or cracks, from ¼ to 1 in. wide, averaging about 20 ft. apart, running at right angles to each other, were cleaned and grouted full with a 1:2 cement mortar, and after chipping off some of the uneven places, the entire rock surface was washed with a cement grouting and used as a floor.

Design Details

The reservoir is a circular reinforced concrete ring tension type, 156 ft. inside diameter and designed for a depth of 14 ft. of water. It is covered with a 5-in.



CONSTRUCTING WALL OF REINFORCED CONCRETE RESERVOIR AT ARKANSAS CITY, KANS., USING THE SLIP FORM METHOD.

reinforced concrete roof slab, carried by 10x15-in. beams spaced 12-ft. centers each way, and supported by 10x10-in. concrete columns. The roof was divided by expansion joints into slabs 24 ft. square, and rests freely upon the beams. The slab was designed for 90 lbs. live load in excess of the dead load. The entire roof was given a slope of 8 ins. from the center to the outside walls.

A trench was excavated in the rock to provide a sub-footing under the walls and to secure a good bond to prevent leakage. In order to provide for the indeterminate cantilever stresses, the sub-footing was finished off smooth and an asphalt expansion joint was provided between the sub-footing and the wall footing proper.

Use of Slip Forms

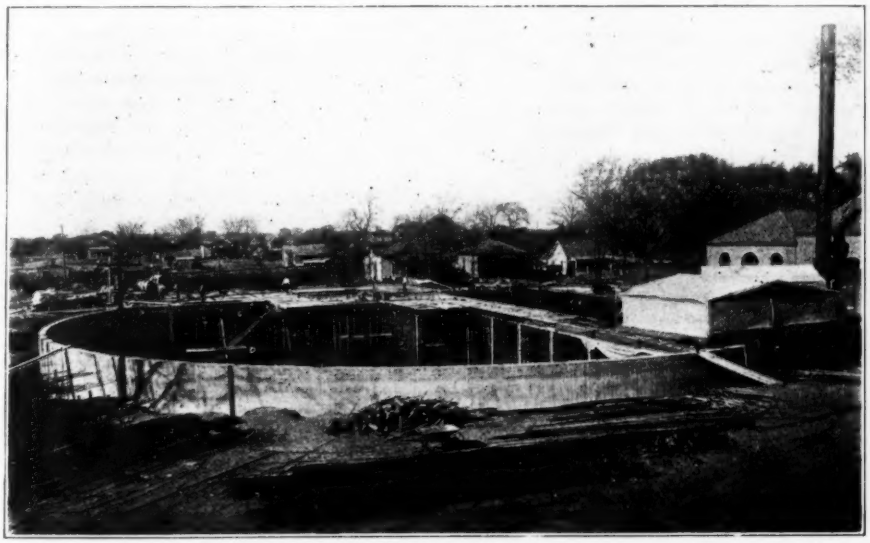
The wall was made 14 ins. thick, without taper toward the top, in order to facilitate the use of slip forms. The horizontal steel was placed in two rows and held in place by vertical standards, 6-ft. centers, built up of 3-in. channels, to which short strap steel lugs, with notches for holding the bars, were riveted at the required intervals. The channel standards facilitated the placing of the steel and insured the proper spacing and against the displacing during the pouring of the concrete. The standards were accurately centered and held in place by braces until the footing was poured, and then the standards were sufficiently rigid to be self-supporting.

A system of slip forms 4 ft. in height and in sections 12 ft. long were made up of 1-in. shiplap and assembled and centered in place. The forms were filled within 6 ins. of the top, and at this point they were raised by means of the ordinary slip form jack operating on a 1-in. jack rod. The jack rods were spaced approximately 8 ft. centers and two men made the circuit twice an hour, raising the form about 1 in. each time. The 1-in. jack rods were cut off at the top of the wall when the pouring of concrete was completed.

Concreting

The wall concrete was run continuously, requiring a total time of 80 hours for completion. Three 8-hour shifts, each consisting of 10 laborers and foreman mixing and placing concrete, 3 men placing and wiring steel, 2 men operating form jacks and 2 carpenters shifting runways and miscellaneous work. Two mixers were placed on opposite sides, but owing to shortage of labor only one mixer was in operation at one time, the crew changing from one mixer to the other every hour. Concrete was conveyed from mixers to wall in wheelbarrows on board runs.

This method of construction eliminated all construction joints and gave a smooth, finished surface which, under water test, showed practically no leakage, and only slight leakage was found through the small fissures in the rock bottom. Column footings were placed and tops carefully graded from center to walls to conform to roof slope, so that all column



CONSTRUCTING ROOF FOR REINFORCED CONCRETE RESERVOIR AT ARKANSAS CITY, KANS.

forms were of the same length, simplifying the construction and placing of forms. A part of the roof was poured during freezing temperatures, the work being protected by using a canvas tent covering, heated with steam coils, heating sand and water for mixing and covering completed work with paper and straw before removing the tent to the next section.

Tennis Courts on Reservoir

The location of the reservoir being on public park property, the top slab was given a float and trowel finish, the manhole openings and ventilators so placed that two tennis courts were laid out on top of the reservoir. Pipe couplings or sockets were installed in the roof slab for installing net posts, and also round the wall for fencing the entire area.

The principal quantities in the construction were 7,162 cu. yds. earth excavation; 1,038 cu. yds. concretet; 71.7 tons reinforcing steel and 4.2 tons channels and miscellaneous.

The total cost of the completed reservoir was $52,887.21. The reservoir was designed by Burns & McDonnell Engineering Co., of Kansas City, Mo.; constructed by Ray & Son, Contractors, of Baxter Springs, Kans., and the work was inspected and supervised by Charles W. Lusk, City Engineer of Arkansas City, Kans.

FEATURES OF ADDITIONAL WATER WORKS FOR ST. LOUIS, MO.

By Edward E. Wall, Water Commissioner, 312 City Hall, St. Louis, Mo.

Eight years ago the writer made a study of the water supply of St. Louis, Mo., the conditions affecting it and the extent to which the existing works could be enlarged, which led to the conclusion that by 1926 an additional supply would have to be provided.

During these eight years the capacity of the existing water works has been increased 50 per cent., the principal additions and extensions recommended at that time have been carried out, and a total of more than $5,000,000 spent for improvements.

When this investigation was made (1912-13), the average daily consumption was 82,000,000 gals. In 1920 it was 104,600,000 gals. During these eight years the highest daily average for one month was 126,000,000 gals., for one week 141,000,000 gals., and for one day 156,000,000. It takes no expert to see that the ultimate daily capacity of the present works (160,000,000 gals.) will in all probability be passed before 1926.

Following the 1912 report, investigation was made of several propositions for building new water works to supplement the present works when their ultimate capacity became insufficient for the demands of the city. A study of these schemes very promptly reduced the number worthy of consideration to two, namely: a practical duplication of the present works at the Chain of Rocks, with an additional high-service pumping station there, delivering water to the western and southwestern portions of the city through three large mains, and an entirely new 200,000,000-gal. plant located on the Missouri River about 9 miles above St. Charles, with a storage reservoir at Stratmanns, on the Olive street road, about 4 miles west of the western city limits, from which the water would be supplied by gravity to the city.

Proposed New Missouri River Plant

When the details of these two propositions were gone into, the Missouri River plant was seen to be preferable for many reasons. An extension of the city limits, which is almost certain to occur before many years, will make it necessary to supply water to a large territory already improved and lying west of the present city limits. This territory would be directly in the line of supply from the Missouri River plant, but would be still farther from the Chain of Rocks than any portion of the city now supplied from the existing works.

The Chain of Rocks is far from being an ideal site for a large water works. The intakes have to be built too far from shore and are at times inaccessible, the channel of the Mississippi is too unstable and too shallow at low water, the difficulty of keeping ice away from the gates, the cost of protecting the intakes and the sudden and freakish variations in the character of the water, all greatly increase the ordinary troubles incident to the operation and maintenance of a modern water plant.

All of these objections are greatly minimized or entirely removed at the site selected for the plant on the Missouri River. There the intake will be connected with the shore by a bridge about 200-ft. long, and will be located in a bend of the river, where it will be comparatively easy to ward off the ice in winter, where there is a depth of 30 ft. at mean low water, and where the water changes its character less often and more slowly

and more in accordance with the rise and fall of the river.

Capacities and Costs.

The initial cost of each of these propositions was estimated in 1914 at about the same amount, namely, about $20,000,000. In neither case was it proposed to spend the full amount for the first installation, but only the amount necessary to construct that portion of the works to supply an average quantity of 60,000,000 gals. per day. About ten years later the work of gradually increasing the plant would be commenced and continued until the full daily working capacity of 120,000,000 gals. was reached.

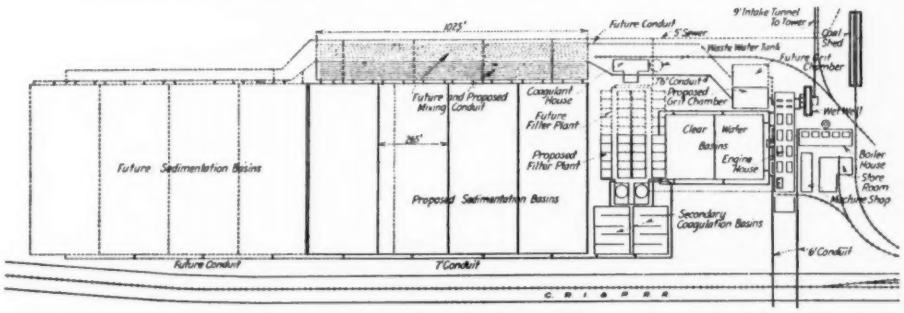
The present works would be continued in operation at their maximum daily working capacity of 120,000,000 gals., the Missouri River plant beginning to supplement this supply in 1926 with an average daily output of 30,000,000 gals. About 1942 this plant should be delivering thrice that amount to the city, and by 1960 its full daily working capacity of 120,000,000 gals. will be reached, at which time it is estimated that the population supplied will be almost 1,500,000, using an average daily quantity of 240,000,000 gals. of water.

Features of Missouri River Plant

The Missouri River plant, as designed, will be located at the foot of the bluffs on high bottom land about 1,800 ft. from the south bank of the river. The water will be drawn from the river, at the intake tower, through a tunnel to the wet well and screen chamber, to which the low-service pump suctions will connect. It will be lifted to a grit chamber, where the velocity will be reduced and the heavier sand dropped. Then it will pass through a conduit, being measured by Venturi meters, to the lime-mixing conduits, receiving the charge of lime en route. It will be in the mixing conduits not less than one hour, will then receive the charge of coagulant and pass into the sedimentation basins, remaining there not less than 16 hours. Drawn from the sedimentation basins it will be treated again, if necessary, in the coagulating basins, and then pass onto the filters. From the clear-water basins it goes to the suction of the high service pumps and thence through the supply pipe lines to the storage reservoir on Stratmann Hill, from which it will be drawn into the city through the service pipe lines to meet the consumption demands.

Intake and Wet Well.

The intake tower will be of concrete, faced with masonry, similar in a general way to the towers at the Chain of Rocks, resting on the bed rock at an elevation of about 40; will be in the channel at the deepest point about 200 ft. from the bank and will be connected to the shore by a steel bridge. The accessibility thus secured will much reduce operating charges. Gates will be provided at varying depths so that the heavy sand charges near the river bottom may be avoided except at extreme low-water periods.



GENERAL PLAN OF PROPOSED MISSOURI RIVER PLANT OF THE ST. LOUIS, MO., WATER WORKS.

The connection between the tower and the wet well near the bluffs will be by shafts and a tunnel 8 ft. in diameter, 2,075 ft. long, driven through bed rock and lined with concrete.

The wet well, screen chamber and engine house foundations will rest on the bed rock, about Elevation 15, and will be of concrete. The screen chamber and wet well will be similar to that at the Chain of Rocks, ice machines being provided to remove slush ice when necessary. The engine house will house the low service pumps, the high service pumps, the generators, wash water pumps for the filters and auxiliaries. It will be 449.5 ft. long by 74 ft. wide (interior measurements)

and will contain a crane running the full length of the building.

Pumps

The low service pumps will be four in number when the installation is completed, two 50,000,000-gal. per day turbine-driven centrifugals being installed when the plant is put in operation, and 100,000,000-gal. per day turbine-driven centrifugals being added as needed, in 1936 and 1947. The average head will be 36 ft.

The high service pumps, as provided for now, are eight 25-million gallons per day triple expansion pumps working against an average head of 280 feet. Three will be installed when the plant is put in operation and others added as follows:

One in 1937, two in 1943, one in 1948, one in 1954.

The generators, for furnishing light and power for auxiliaries and the filters, will be in the south end of the building, two being installed at first and a third as required later.

The wash water pumps for the filters will be installed in the engine house. The concentration of all machinery under one roof will make for reduced operation cost and greater plant efficiency.

An office will be provided for the chief engineer and the clerk on the west of the building.

The boiler house lying east of and centering on the engine house will house five batteries of two 500 horsepower boilers each, provided with stokers, coal bunkers, conveying machinery, etc. Two batteries will be installed when the plant is started and additional ones in 1936, 1943 and 1946, as required. The building will be 205 feet long by 63 feet wide. The stack will be 225 feet high by 9 feet in diameter.

Additional buildings provided in connection with the pumping plant are a machine shop and blacksmith shop; locker and bath rooms are provided in the same building; a storeroom and yard and a storage coal shed.

All buildings, with the possible exception of the storeroom, will be built full size at the beginning.

Purification Plant

The purification plant will consist of the grit chamber, coagulant house, lime-mixing conduits, sedimentation basins, coagulating basins, head house, filters and clear water reservoirs, with connecting conduits. In the beginning the coagulant house, coagulating basins and head house will be built full size for the complete plant. All other parts will be built half size only and brought up to full capacity in 1941, when the demand exceeds an annual average of 60 million gallons per day. All will be of reinforced concrete with the exception that the building will be of the same materials as the pumping plant buildings. All descriptions are for parts to be built at first.

The grit chamber, designed to still the water to a velocity not exceeding 0.13 ft. per second, so that the heavier sand may be deposited, will be in three compartments, each hopper bottomed and connected to sewers so that the deposit may be flushed back into the river. It is 106 ft. long by 75 ft. wide by 18.5 ft. deep (average). The high water elevation will be 51.5. The water coming from the grit chamber will pass through a Venturi meter and conduit to the lime-mixing conduit, receiving the charge of milk of lime as it passes the coagulant house.

The coagulant house will contain the apparatus for mixing the dosings of lime, sulphate of iron, sulphate of alumina, etc., and the bins in which the chemicals used in the treatment of the water are stored 30 days' storage for each is contemplated.

The lime-mixing conduit, of concrete, covered, 9,225 ft. long by 64.8 ft. wide by 6.5 ft. deep, will contain nine channels, each 1,025 ft. long by 6.5 ft. wide by 6.5 ft. deep, with a total capacity of 3,000,000 gals. The water will be in agitation in this conduit not less than one hour, during which time the softening reactions should be completed. The coagulant will be added just before the water leaves this conduit.

Sedimentation Basins

The sedimentation basins are designed to allow a minimum of 16 hours' settling. They are made shallow, 12 ft. working depth, to reduce soil pressures and to prevent any such leakage and blow-out troubles as have been experienced at the Chain of Rocks. The original ground level varies from Elevation 36 to Elevation 40, while the working water surface will be Elevation 48.

The basins will be open with walls of reinforced concrete and bottoms of two layers of concrete blocks, breaking joints with a waterproofing layer between them. The water will enter at the river side through a number of openings and will be drawn off on the opposite side. The total capacity of the basins will be 60,000,000 gals., each of the four having an area of 167,110 sq. ft. and a capacity of 15,000,000 gals. Connections will be provided to a main sewer draining the whole plant.

A conduit will connect the basins to

the coagulating basins, where another charge of coagulant may be added when necessary. These will be two in number, each 131x170x12 ft. deep.

Filters

The filters are of the same general type as used at the Chain of Rocks, arranged about two main operating galleries, with wider pipe galleries and a clear water reservoir underneath. The filters will be 20 in number, each with a nominal capacity of 4,000,000 gals. per day.

The head house, at the entrance to the filters, will contain the wash-water tanks, the chemical and bacteriological laboratories, offices, locker and store rooms.

During a part of one month each year the river will be above the sewer outlets of the filters. A waste water tank, 48 ft. in diameter and 12 ft. deep, is provided near the coagulant house, connected to waste pumps in the house to provide for washing at such times.

The clear water reservoir connected to the suction of the high service pumps will have a capacity of 4,000,000 gals. and will be 184 ft. wide by 246 ft. long by 12 ft. deep. It will be covered.

Provision has been made for conduits, gates and connections, so that any part of the plant, except the sedimentation basins, may be by-passed.

The Stratmann Hill Reservoir

Between the river plant and the reservoir on Stratmann Hill, two supply mains are provided, each 6 ft. in diameter and each designed to carry 80,000,000 gals. daily, only one of which will be laid with the initial installation, the second being needed about 1942. The ground most suitable for a reservoir lies between the Bonhomme and Link roads and south of the Olive street road. Surveys have been made and contours drawn. The reservoir will have a capacity of 200,000,000 gals., and will be divided into two basins, each 1,042 ft. long by 437 ft. wide by 30 ft. working depth. The sides will be earth filled, 20 ft. wide at the top, with slopes of 1 vertical to 1½ horizontal on inside. The sides and bottom will be of concrete blocks 6 ins. thick, with a waterproofing layer of asphalt and felt and a protective layer of concrete. The top will be of concrete of flat slab construction, with a 2-ft. earth cover. The division wall will be of concrete.

The working water level will be at Elevation 310 and the reservoir bottom will be at Elevation 280. The ground at Stratmann Hill is good yellow clay and shale, so bearing stresses can be high. Gate chambers are provided for inlets and outlets and by-passes, so that both reservoirs may be withdrawn from service.

Service Mains

The service mains from Stratmann Hill reservoir to the city must be large enough to carry the maximum hourly consumption (at the rate of 270,000,000 gals. daily) and deliver the water at the city limits at Elevation 273 when the water in the reservoir is at Elevation 300. The points of entry into the city best to distribute the supply cannot be definitely determined at this time, but it is desirable that at least half be used in the district south of Forest Park. Four lines have been provided for in the estimates, one to be laid when the plant is put in service and to run on private right-of-way (100 ft. wide) to Maplewood, at Hope avenue, and crossing Manchester avenue to enter the city on Old Manchester road. This estimate ends the service main at Ellendale avenue, extensions from that point being handled by the distribution section. A second main, in 1933, will parallel the first. The third and fourth mains will be laid down Olive street in 1941 and 1950, respectively, as far as the city limits, where they will tie into the distribution system. These limits are, of course, tentative only, as it is impossible to predict the districts in which the consumption will be heaviest.

Each main will be of the same size and construction as the supply mains, and will be able to deliver 67,500,000 gals. per day at the city limits at Elevation 273.

The land for Stratmann Hill reservoir has already been purchased by the city, and negotiations for the necessary acreage on the Missouri River are now being conducted.

A bond issue of perhaps $16,000,000 will be proposed this year, to cover the cost of intake tower and tunnel, and that part of the buildings, basins, conduits, mains, etc., necessary for the first protion of the plant. A second bond issue of $10,000,000 or $12,000,000 will have to be made about 1940, to complete the plant to its ultimate daily working capacity of 120,000,000 gals.

PERKINS COAL HANDLING MACHINERY IN TWO ILLINOIS STATE POWER PLANTS

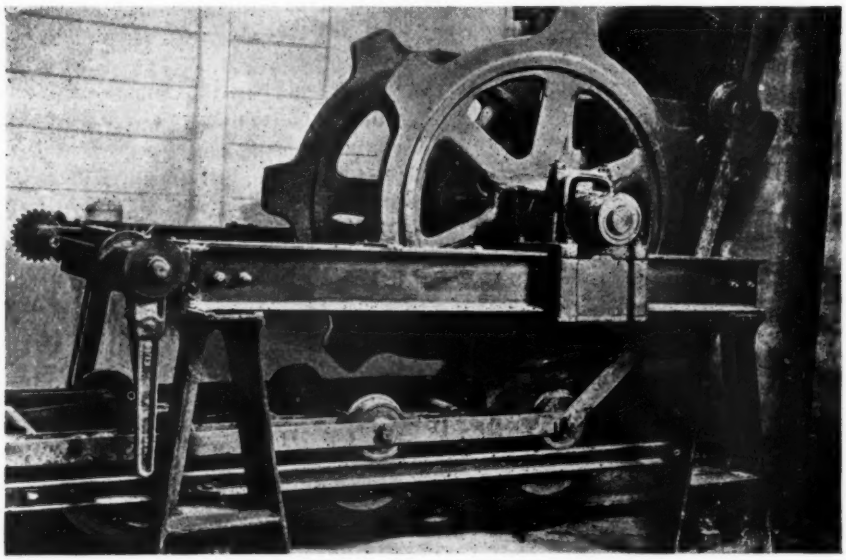
By W. F. Leggett, 2017 Sherman Ave., Evanston, Ill.

The list of things that come in pairs is a large one, but it is rare that two power plant coal handling installations are erected simultaneously, and are exactly alike in design, so that the location of each plant is the only means of telling them apart. Such, however, is the case with equipments recently installed in the power plants of the State Hospital at Alton, Ill., and the State Colony of Epileptics at Dixon, Ill. Plans and specifications for the two jobs were made at the same time by the consulting engineer for the Illinois State Board of Administration, and the parts were manufactured at the same time. The illustrations are from photographs taken at both plants and the description applies equally well to either installation.

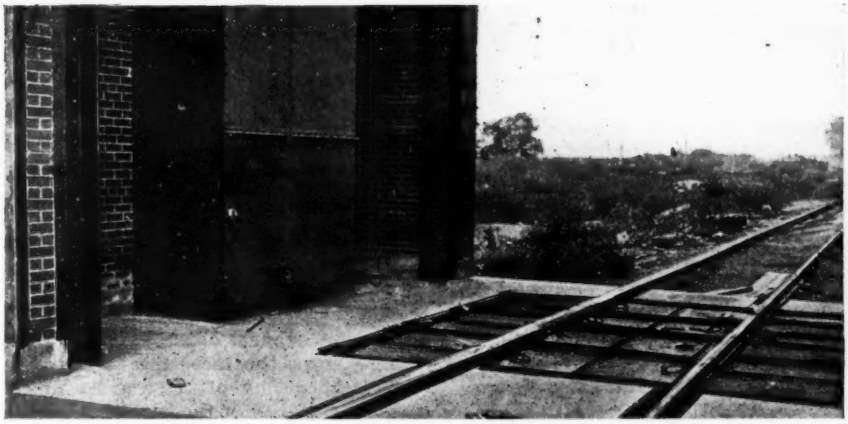
Either run of mine or stoker size coal is received in hopper bottom cars, which are dumped into the track hopper, from which the coal is passed in a steady flow by a reciprocating feeder. If run of mine coal is being unloaded, the feeder passes it to a crusher, where two 24x24-in. semi-steel rolls reduce it to 1¼-in. stoker size before it passes into the Perkins pivoted bucket carrier, which is installed below the reciprocating feeder. If stoker coal is being handled, it by-passes the crusher rolls and is carried to the upper corner of the pivoted bucket carrier, where it takes a horizontal path and is discharged into the proper bunker, from where it is fed through spouts to the stokers.

The pivoted bucket carrier is composed of 24x15-in. malleable iron buckets hung on 1-in. rods between two strands of steel bar chain having 5/16x2½-in. side bars. It follows a rectangular path 118 ft. long on the horizontal runs, and 50 and 58 ft. high on the two vertical runs, the latter being higher than the former because of the dip under the crusher and feeder. The upper horizontal run is shown in one of the illustrations.

The engineering specifications call for a capacity of 20 tons per hour, but the Perkins carrier will easily handle twice this volume of coal, and is demonstrating its flexible utility as a conveying system by handling ashes as well as coal. When an ash run is to be made the doors of the ash pits are opened and the ashes are discharged into the lower run of the conveyor. The ash bunker is placed directly over the receiving track at the beginning of the upper horizontal run, and by setting the dumping mechanism at this point, the ashes can be collected until a carload has accumulated. The bottom of the ash bin is equipped with a rack and pinion gate, which is operated by a hand chain, and under the gate is a steel spout mounted on rollers which operate on a steel track, so that when ashes are being loaded it will project close to the car, but when



TAKE-UPS AT LOWER CORNER BELOW DRIVE.



TRACK HOPPER AND CASING FOR VERTICAL RUN.

idle it can be pushed out of the way. This spout is controlled by chains, and is entirely independent of the gate.

This installation is typical small plant equipment, and can be amplified to meet any requirements.

THE ECONOMY OF FEED WATER HEATING AND PURIFYING IN THE WATER WORKS PUMPING STATION

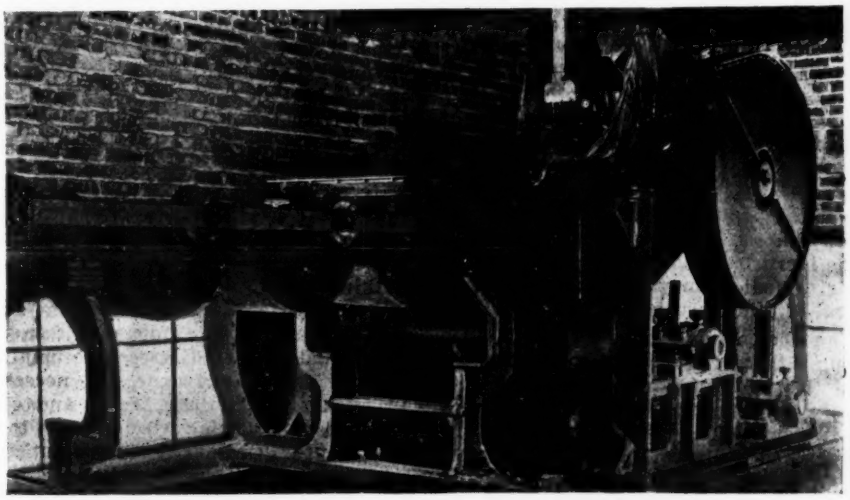
By Milton F. Stein, Civil Engineer, 6753 Lafayette Ave., Chicago, Ill.

Utilization of Heat from Exhaust Steam

In some smaller pumping stations, where non-condensing engines are used, the steam exhausts to the atmosphere. In larger plants, where the main units are condensing, the auxiliaries still furnish considerable exhaust steam. The utilization of this exhaust steam for feed-water heating is a very decided step toward economy. In the majority of cases feed-water heaters are provided, but there are enough exceptions to this rule, and enough instances of feed-water heaters improperly installed, poorly operated or entirely neglected to justify a few remarks on this subject.

In the very small steam-operated pumping station, using non-condensing engines, the preheating of feed water is of course a logical step toward economy. Ample steam being available in this case, it is possible to heat the feed water to over 200 degs. F., which results in a fuel saving of over 12 per cent.

Where condensing engines are used, there is still considerable steam from the auxiliaries which may be used for feed-



DRIVE CORNERS AT END OF UPPER RUN.

water heating. Indeed, it is more economical to use the exhaust steam from auxiliaries for this purpose than it is to operate them condensing, unless economizers are used to heat the feed water, which is impracticable in any but the largest pumping stations, and even there is of debatable value. The amount of steam available from auxiliaries is indicated in the following data for a station pumping about 3,000,000 gals. per day against 150 lbs. dynamic head. This plant supplies mechanical filters and repumps the filtered water to a service reservoir. It is modern in every respect.

Pump Unit	Lbs. of Steam Per Hour
High service pump	2,950
Vacuum pump for same	159
Low service pump	344
Vacuum pump for same	76
Boiler feed pump	127
Jacket returns	283
Total	3,939
Auxiliaries	545

Percentage auxiliaries of total, 13.8.

With this amount of steam it is possible to heat the feed water from 60 degs. F. to 210 degs. F., resulting in a fuel saving of 12.5 per cent. Furthermore, since a portion of the work of the boilers is transferred to the heater, the capacity of the former is in effect increased, in the present instance by one-seventh.

Types of Feed-Water Heaters

The two types of heaters are the open and the closed. The open heater is essentially a tight box into which the exhaust steam discharges. The water to be heated enters a distributing trough at the top, and from this flows evenly over a series of trays arranged horizontally, with a slight pitch, one above the other like shelves. The principal absorption of heat occurs in the drop from tray to tray, but also, to some extent, in flowing over the trays. As the feed water contains various salts in solution which precipitate out when the water is heated, the trays become incrusted, and provision is made for their periodic removal for convenient removal of this incrustation.

The efficiency in the main depends upon keeping these trays clean, so as to maintain the uniform flow of water in thin sheets, and prevent short circuiting of the water, which would reduce the time element as well as the intimacy of contact between water and steam. It is also important that the trays be accurately leveled or adjusted so as to give a thin, uniform sheet of flow. These are points for the operating engineer to observe, if he would obtain the greatest return from the exhaust steam. As an indicator of results, a reliable thermometer should be placed in the feed-water line leading from the heater to the boiler feed pump, and with sufficient steam and properly proportioned heater, this should read at least 200 degs. F. The engineer can answer the question as to sufficiency of exhaust steam by comparison of his plant with the example given.

As the exhaust steam is condensed and mixed with the incoming water, there is a direct saving of the residual heat in this, as well as of the resulting, practically distilled, water. However, a certain amount of oil from cylinder lubrication is returned with the steam. To remove this, an oil separator is placed in the exhaust steam line as it enters the heater, which is more or less successful. The presence of oil in the feed water is one of the arguments against the open heater. When used in connection with a water softener, this objection vanishes, as the oil is removed in the softening process.

In the closed heater the exhaust steam and the feed water are kept separate. It consists of a series of tubes or of coils, through which the feed water flows, inclosed in a shell of steel or cast iron. The exhaust steam fills this shell, and its heat is transmitted through the tubes to the feed water. In order to retard the steam within the shell until it is condensed, a back-pressure valve is usually placed on the steam outlet from the heater to the exhaust stack.

The advantage of this construction lies in the separation of the oil-containing exhaust steam from the feed water. Other advantages claimed, such as the reduction of load on the feed pump, by use of water from the city mains, are not justified, as the steam thus saved would be usefully employed in heating the feed water. For the same reason the back pressure caused by this type of heater results in no actual loss in plant efficiency. The feed water can be heated to within 10 to 15 degs. of boiling point (or temperature of the exhaust steam). As incrustation rapidly forms within the tubes, and a layer of grease accumulates on the steam side of same, it is necessary frequently to open the heater and clean the tubes if a high efficiency is to be maintained. Ordinarily this attention is required several times annually, and its need is indicated by the lowering of feed-water temperature.

Feed-Water Purifiers

It is surprising that while most other power plants, even of small size, use feed-water purifiers or softeners, these are very rarely seen in water works pumping stations, even of large size. Perhaps the water works engineer feels that he must demonstrate to the public his faith in the purity and steaming quality of the water he sells. Nevertheless, in a majority of cases the water could to advantage be softened for boiler use. Most well waters and many surface waters contain salts of calcium and magnesium in sufficient amount to build up a scale in the tubes and drums of the boilers, when they are precipitated by heating and by concentration in the boiler. This scale interferes greatly with the transmission of heat through the tubes to the water, and the heat which should go toward making steam goes up the stack instead, resulting in a marked waste of fuel. The scale can be removed by turbining, but even if this is faithfully done, it is impossible to avoid a heat loss of 5 or 6 per cent. as compared with a boiler that is always scale-free. In addition, there are the labor involved in turbining and scale removal, and the loss of service of the boiler for several days every three or two months or monthly, according to the scale quality of the water used, and the depreciation of the boiler due to overheating of the scale-covered surfaces and resulting from the process of scale removal. Under average conditions I do not think that the heat loss through boiler scale is less than 10 or 12 per cent. This loss, the labor and time of turbining, and the deterioration of boiler plant can be avoided by softening the feed water. Furthermore, the blowing off of boilers can be reduced to a minimum, and lubrication troubles in the steam end of pumps due to carrying over suspended matter with the steam are eliminated.

Water Softeners Using Lime and Soda Ash

The most usual types of water softeners make use of lime (either quick or hydrated) and soda ash as chemical reagents. These reagents are mixed with water to an appropriate strength in solution tanks provided with stirring mechanism, and the resulting solutions are fed into the water to be softened by automatic devices which proportion them to the amount of water used. After thorough mixing with the applied chemical solutions the water is allowed to settle in a large tank for several hours, then flows through a sand filter and is pumped into the boiler. The settling tank is so proportioned as to act as a storage reservoir, and takes care of the fluctuations in demand due to variable load on the boiler plant. The filter is of the closed type, operating under pressure, and requires no attention except a washing by back-flushing every day or two. The precipitate which accumulates in the settling tank is drawn off at intervals of one or more days through a blow-off valve at the bottom of the tank. By means of three simple chemical tests made daily upon the softened water it is possible to adjust the strength of the lime and soda solutions so as to obtain a boiler feed water of minimum hardness.

These softening reactions, like most chemical reactions, proceed much more rapidly in hot water than in cold. Therefore, it is advantageous first to pass the water through an open feed-water heater of the type above described, and water-softening apparatus for boiler plants is often designed with such a heater as an integral part, usually set on top of the settling tank. By this combination the troublesome question of oil returned with the steam is solved, as such oil is saponified and coagulated by the lime and soda in the settling tank and carried to the bottom with the precipitate. By using this so-called "hot process" of water softening the reactions are accelerated and the resulting precipitate is heavier and settles more rapidly to such an extent that the settling tank need be only one-fourth as large as for a "cold process" plant of the same capacity, which results in a saving in first cost sufficient to cover the additional item of the open feed-water heater. It is almost needless to add that if the feed water contains silt, mud or other matter which would cause foaming in the boiler, this will be carried down by the precipitate in the settling tank, so that the resulting feed water will be perfectly clear.

Zeolite Water Softeners

Within recent years another type of water softener has been placed on the market. This consists of a mechanical filter of the usual type, which contains, in place of sand, a mineral called zeolite, or sodium aluminum silicate. This mineral is found in natural beds, but is also prepared artificially, both the natural and synthetic products being on the market under various trade names. When water containing scale-producing calcium and magnesium salts is passed through a bed of zeolite, an exchange takes place, whereby the zeolite takes up the calcium and

magnesium and gives off an equivalent amount of sodium, which remains dissolved in the water. It is thus changed in character from a hard water containing calcium and magnesium, to a soft water containing sodium, while the zeolite is changed from a sodium zeolite to a calcium-magnesium zeolite.

It should be noted that whereas the lime-soda process removes the objectionable salts from the water and reduces the total dissolved solids to a very low amount, the zeolite process exchanges objectionable salts for others, the total dissolved solids remaining unchanged in amount. As sodium salts are known to aggravate foaming, it follows that if a very hard water is softened by the zeolite process, it will indeed be softened, but in its changed condition may cause trouble through priming and foaming. It is also known that waters high in sodium salts have an embrittling action on steel, which may cause a rapid deterioration of boilers. For these reasons the use of zeolite softeners as applied to boiler feed water is rather limited, although it ranks very high in other fields of water purification.

It is evident from the foregoing that the character of the zeolite is changed by use, and to change it back to its original effective condition a salt solution is passed through it, after it has been in use for one or more days. This regeneration requires several hours, the brine solution resulting being wasted into the sewer. After regeneration, the zeolite bed must be thoroughly washed by a reversed flow of water, and is then ready for use again. The cost of salt offsets the cost of chemicals in the lime-soda process, so that an advantage of the zeolite process lies in the smaller size of installation, and in the ease of control, no dosing apparatus being required, and only a single, simple chemical test being necessary to determine when regeneration becomes necessary.

CONDITIONS GOVERNING INSTALLATION OF MUNICIPALLY OWNED POWER AND LIGHTING PLANTS

By C. M. Garland, Consulting Engineer, 1140 *First National Bank Bldg., Chicago, Ill.*

There are few communities today that are not served with power and light in some manner by public utility corporations. The principal object, therefore, eliminating politics and possibly the poor service of the local utility, for the installation of municipally owned power plants for lighting and power purposes is to save money for the community. In order to reach a decision, therefore, on a municipally owned plant, it is of the first importance that all the conditions be properly analyzed and proper conclusions drawn therefrom.

Governing Conditions

There are undoubtedly many communities in which a municipally owned plant, properly designed and properly operated, can be made to save the community considerable in the cost of light and power. There are just as many communities in which a municipally owned plant will cost the community considerably more than power purchased from the public utility corporation. As to whether the municipally owned plant will be an asset or a liability to the community depends:

1. Upon the size of the load.
2. Upon local conditions.
3. Upon the cost of power from the public utility.
4. Upon the efficiency of the plant built.
5. Upon the efficiency of operation.

The Size of Load

The size of the load affects the cost directly. It goes without saying that for small and medium sized plants, the overhead charge, plus the labor charge, plus the repair charge, are charges that are almost constant and almost independent of the load within comparatively wide limits. A proper load will therefore be one of the principal considerations in the decision as to whether or not a municipally owned plant should be installed.

Influence of Collateral Conditions

Assuming that there is sufficient load available to warrant the installation of a power plant, the next consideration is the question of local conditions. Ordinarily for a municipally owned installation to be an asset to a community, the load must be large enough to warrant the installation of condensing equipment. This means the supply of an abundance of water for condensing purposes. Where an abundance of water is not available for condensing purposes spray ponds or cooling towers must be considered which raise the cost of the installation.

Again, the status of the water supply for the town may be a valuable consideration in the decision regarding the installation of a power plant. Where the water works can be combined with the power

MUELLER
Sanitary Drinking Fountains

There is a MUELLER model to meet every need. The three designs here shown—E-3650, E-3758 and E-3632—are all popular styles for parks and public buildings.

Each MUELLER Fountain combines the most approved sanitary construction with beauty of design and quality of materials and manufacture. We are equipped to supply special fountains for unusual conditions.

Write for full information and prices.
Mail orders given prompt attention.

H. MUELLER MFG. CO., DECATUR, ILLINOIS U. S. A.
Phone Bell 153
Water, Plumbing and Gas Brass Goods and Tools
New York City, 145 W. 30th St. Phone Watkins 5397
San Francisco, 635 Mission St. Phone Sutter 3577
Sarnia, Ontario, Canada
Mueller Metals Co., Pt. Huron, Mich., Makers of Red Tip Brass and Copper Rod and Tubing; Forgings and Castings in Brass, Bronze and Aluminum; also Screw Machined Products.

plant a very large saving in overhead can be effected. There may be also a considerable saving effected in the first cost of the plant through the reduction of the spare equipment required. It may also be possible to combine the pumping load of the water works with the power and lighting loads, to bring about a higher load factor on the combined plant. This is a consideration of the first importance.

Under local conditions also enters the cost of fuel for the particular locality. In some localities, a long distance from mines, the price of coal may make the installation entirely prohibitive. Again, the plant may be located near a mine and obtain fuel cheaper than the public utility corporation.

Cost of Power from Private Company

The cost of power from the local public service company is the next point to be considered, and in considering this item

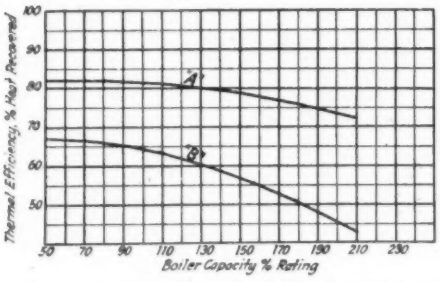


FIG. 1—CURVE A SHOWS ECONOMY ATTAINABLE WITH PROPER STOKERS AND BOILERS FOR SMALL AND MEDIUM SIZED PLANTS; CURVE B SHOWS WHAT USUALLY HAPPENS.

it must be borne in mind that the estimated cost of power at the switchboard for the municipally owned plant is not the price that can be charged by the plant to the consumers. This is a point that is often overlooked in local arguments by the layman in installations of this nature. The public utility rates to householders may, for example, average 10 cts. per kwh. The fact that a local plant may generate current for 3 cts. per kwh. at the switchboard does not mean that the municipally owned plant will be able to deliver current to its consumers at anywhere near this amount.

Reported costs of power from any plant must be very closely scrutinized, otherwise misleading conclusions may be arrived at; this is particularly true of municipally owned plants where interest on bonds, overhead charges, and, at times, operating expenses may be paid out of the city tax returns. Where such items are omitted from the cost, the plant shows a fictitiously low cost for power.

When the cost items are entered up properly on small installations it will be found that there are few installations in which the cost of power can be brought under 10 cts. per kwh., delivered to the consumer.

Plant Efficiency

Having decided that a municipally owned plant can be made a profitable investment for the community, the next step is to obtain an efficient plant. There is a decided tendency on the part of the layman, which is natural, and on the part of practical operating engineers to minimize the importance of a properly designed plant. This is due to the lack of knowledge of the many causes affecting the ultimate economy of a power installation. It is of the first importance that the plant be designed right to start with. If it is not so designed, the errors made in the design of the plant last just as long as the plant and exact a heavy toll from the consumers. As a matter of fact, the economy of the plant depends upon the selection of every piece of equipment entering into it. An economical plant cannot be designed by an engineer who is not familiar with the economy of each piece of apparatus entering into the plant, and there are few engineers that possess this knowledge, as the large number of uneconomical plants will testify.

The economy in the boiler room will depend upon the kind of fuel available. The economy in the use of this fuel will depend upon the selection of stokers, the selection of the boilers, the adaptability of the stokers to the boilers and the adaptability of the stokers and the boilers to the character of the load. The cost of the boiler plant will also depend upon these selections. It is entirely possible to build a boiler plant from the best equipment available, pay the highest price and yet obtain a plant poor in the use of fuel. It is not the cost of the equipment nor the quality of the equipment that decides the economy of a plant.

Take the curves of Fig. 1, for example; these illustrate the difference in economical results that may be produced by the installation of different boiler and stoker equipment, all of which are standard, well-known equipment. The curve marked "A" shows what can be accomplished in the way of economy by the installation of the proper stokers and boilers for small and medium sized plants. The curve marked "B" shows what is more likely to

Farley Gannett Theodore E. Seelye Samuel W. Fleming, Jr.

Gannett, Seelye & Fleming, Inc.

ENGINEERS

Erie, Pa.
Ariel Building

Harrisburg, Pa.
204 Locust Street

Memphis, Tenn.
Randolph Building

Water Works, Power Plants, Electric Problems,
Roads, Bridges, Special Investigations.

Sewers, Sewage Disposal, Water and Sewage Analysis,
Reports and Estimates for Bond Issues.

Valuation of Public Utilities for Rate Making and Purchase.

GANNETT, SEELYE & FLEMING, Inc.
ENGINEERS

happen. The probabilities are that in the building of a new power installation the owner will obtain the economical performance as illustrated by curve "B" rather than by curve "A." The probabilities are at least ten to one against his obtaining the combination of equipment that will produce the curve "A," although this equipment will cost only 10 per cent. more than the equipment which produces the curve "B," and the difference in first cost will be paid off by the saving in coal in the first nine months of operation. If the coal bill for curve "A" is $50,000 per annum, the coal bill for curve "B" will be approximately $62,500 per annum, or a difference of $12,500 per annum in the operating costs.

What is true of the boiler room is true in a measure, although to a much less extent, of the turbine room. The selection of auxiliaries is another important item for consideration.

Efficient Operation

Assuming that a properly designed plant has been secured, the next thing is to obtain efficiency in operation. As a rule, small plants cannot afford to pay for a high degree of efficiency in the operation. For this reason, as a rule, small plants cannot supply power and compete with public utility rates. While a properly designed plant makes it possible to obtain the best oconomy in operation, this economy cannot be obtained and cannot be maintained unless the plant is operated by men having full knowledge of the requirements for economical operation. If the public utility plant is operated on the patronage system, the probabilities are that it will be poorly operated and will be a liability instead of an asset to the community. For this reason, whenever possible, the management of a municipally owned plant should be vested in a commission or board of directors of non-partisan origin, as nearly as this is practicable, and these should be guided by an engineer outside the community specializing in power plant design and operation.

OPERATING DATA ON WURL SCREEN AND IMHOFF TANKS IN PLAINFIELD (N. J.) JOINT SEWAGE WORKS

By John R. Downes, Superintendent Plainfield Joint Sewage Works, Bound Brook, N. J.

(Editor's Note: The operation of the Plainfield, North Plainfield and Dunellen, N. J., Joint Sewage Disposal Plant for four years, has made available some data on quantities of solids removed, both by the Wurl screen and the Imhoff tanks. These data are here given in brief form, as presented by Mr. Downes before the New Jersey Sewage Works Association. He writes that a strong sentiment prevailed at the meeting in favor of the one story settling tank, with a separate digestion chamber, communicating therewith by control valves, as against two-story tanks, with uncontrollable slot connections between the two compartments.)

The works was designed to handle the sewage from 40,000 persons. The sludge separating portion of the plant originally consisted of six Imhoff tanks, each with a total flow length of 64 ft. and a total width of 25 ft. Each tank has four longitudinal settling compartments, with effective widths of 5 ft. each. Two gas vents, each 22-ins. wide in the clear, extend the entire length of the tank. The walls extend perpendicularly to 5 ft. 6 ins. below the flow line. The slopes, about 1 on 1, extend to the slot, 11 ft. below the flow line.

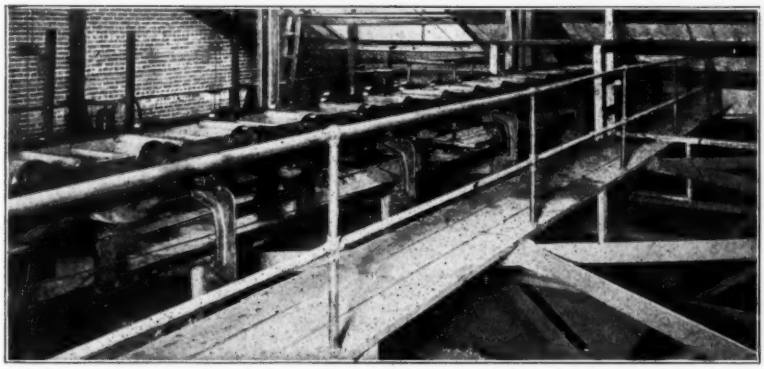
Screen Installed Two Years After the Tank.

The tanks were put into operation at the end of November, 1916, and operating experiences during the ensuing year indicated the necessity of removing the coarser solids, paper, fiber, hair and fecal matter from the sewage before it was admitted to the settling compartments; such solids not being amenable to treatment in the tanks. For the purpose of removing these coarse solids a Wurl screen was added to the slude separating equipment and was put into operation in September, 1918.

The Wurl screen is essentially a brass disk, 10 ft. in diameter, revolving on a shaft inclined 15 degrees. The disk is perforated with some 12,000 slots each 1-16 by 2 ins., and is submerged to about half its depth in the flowing sewage. The solids which are caught on the surface of the screen are swept into a trough by the revolving brushes, which continually scour the unsubmerged portion of the disk. A one-horsepower electric motor, which can be adjusted to run at speeds from 600 to 1800 R. P. M., operates the screen mechanism.

Table I gives information concerning the suspended solids in P. P. M., as determined by the Gooch Crucible method; the number of cubic yards of digested sludge removed from the tanks, (measured by shutting off the tank during drawing of sludge and measuring the depres-

WEBSTER



COAL AND ASH CONVEYORS

The real merit of Webster equipment and the reason it gives 100% service is because each installation is exactly fitted to the work it is called upon to perform. Our engineers are not restricted to a limited range of sizes and designs. Back of each installation is an individual engineering plan which is permanently reflected in wonderful service performance at low operating cost. In this way is maintained the high standard that has been expected of Webster equipment for nearly half a century.

Webster engineers thoroughly understand power plant conveying equipment, and therefore design machinery that is exactly fitted to the specific work it is called upon to do—each part in accurate relation to all other parts, thus insuring undisputed economy in handling costs.

This is why Webster equipment is always specified by power plants that are known for efficient operation.

THE WEBSTER MFG. COMPANY

4500-4560 CORTLAND ST., CHICAGO

Factories-Tiffin, O. Michigan City, IND. *and* Chicago-Sales Offices *in* Principal Cities

TABLE I—OPERATING DATA ON SCREENS AND TANKS IN PLAINFIELD, N. PLAINFIELD AND DUNELLEN, N. J. JOINT SEWAGE DISPOSAL PLANT.

Date.	Suspended Solids. P. P. M. Screen Effluent.	Imhoff Effluent.	Slude from Tanks. Cu. Yds.	Beds. Cu. Yds.	Screenings. Total Cu.Ft.	Daily. Cu.Ft.	Flow Total M.G.	Flow Daily M. G. D.	House Connections 4,500 start 5,400 (6 months
1917	*148	37	1609	586	.....	..	939	2.6	5853
1918	*140	49	3520	1009	.....	..	1253	3.4	6398
1919	*142	38	4069	877	18250	50	1391	3.6	6804
1920									
Dec.	176	71	....	12	1220	47	110	3.6	6905
Jan.	135	70	....	....	1362	45	109	3.5	6909
Feb.	123	69	....	28	1273	44	100	3.5	6912
Mar.	116	67	415	....	1393	46	133	4.3	6921
Apr.	157	66	230	97	1383	46	113	3.8	6943
June	181	57	631	202	1302	43	93	3.3	6993
July	175	57	475	92	1426	46	107	3.5	7003
Aug.	152	48	523	129	1420	46	93	3.4	7036
Sept.	174	65	575	251	1282	41	96	3.2	7076
Oct.	193	66	364	109	1567	52	97	3.1	7078
Nov.	208	82	346	69	1359	45	95	3.1	7111
1920									
May	148	80	248	61	1364	44	105	3.4	6969
Average	161	66							
Totals			3807	1140	16351		12430		

*Raw in 1917, 1918, 1919. Higher results in 1920 due to mixing and comminuting effect of screen on the solids. Samples during 1919 were taken before sewage passed the screen.

sion of the water level); the number of cubic yards of air dried sludge removed from the drying beds, (cart measurement); the sewage flow in million gallons, and the number of house connections at the end of each month.

Two of the municipalities contributing to the plant were installing sewers for the first time and the third took in large new sections of sewers, so that the increase in number of connections during the first year was very rapid. In order to make the complete sludge data of the four years available for estimation of per capita and per connection quantities, the number of connections at the end of each month have been added together and multiplied by thirty to get the number of connection-days contributing the observed quantity of sludge; five times this figure is considered the number of person-days. This figure checks up well with the known population.

Screenings were measured in a wagon, most of the free water having drained away before measurement was made. The dry solids equal 11%.

Comparing the volume of solids removed by the screen with the total volume of settleable solids, indicated by cone glass sodings, indicates a removal of 15 per cent. of the latter. Comparison of weight of screenings with weight of suspended solids indicates a removal of 7 per cent. of the total suspended solids on a dry basis and the screen removes 10 per cent. of the solids removed by the combination of screen and tanks. Screenings indicated in above table amount to .0015 cu. ft. per person-day. Digested sludge indicated in above table amounts to .0085 cu. ft. per person-day.

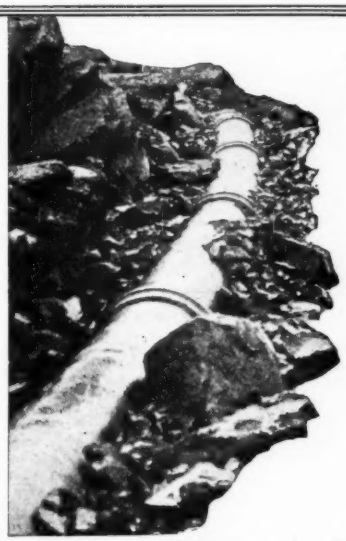
Sludge

At the end of the 4th year of operation a sludge survey of the digestion compartments indicated that there remained at that time 750 cu. yds. of sludge. In three of the tanks the sludge was at the bottom of the hoppers and in the other three it was almost entirely floating at the surface of the gas vents. (This in spite of constant effort to beat it down.)

In addition to the above solids there has been removed from the gas vents a quantity of partly digested sludge estimated at 1,000 cu. yds. This was removed by pumping and by wheelbarrows and ranged in constency from a watery 96 per cent. sludge to a viscous 88 per cent. mass, containing much hair and fiber.

The sludge digesting portion of the plant consists of ten sludge hoppers to each tank. These are in two rows of five each, directly beneath the gas vents. The depth between the slot communicating with the settling compartment and the top of the hoppers is 6 ft., providing a total settled sludge capacity of 57,000 cu. ft.

With any operating program, which we have been able to develop, there accumulates, in time, a mass of floating sludge



Bell and Spigot Joints Cast Iron Pipe

This type of joint is flexible enough to allow for the expansion and contraction of a line under temperature changes. Long easy curves may be laid without specials. No iron-to-iron joints to rust together, forming a rigid line always to be avoided in exposed installations.

United States Cast Iron Pipe & Foundry Co.

General Office, Burlington, New Jersey

SALES OFFICES:

Philadelphia: 1421 Chestnut St.
Pittsburgh: Henry W. Oliver Bldg.
New York: 71 Broadway
Chicago: 122 S. Michigan Blvd.
St. Louis: Security Bldg.
Birmingham: 1002 American Trust Bldg.
San Francisco: Monadnock Bldg.
Dallas: Scollard Bldg.
Minneapolis: Plymouth Bldg.
Cleveland: 1150 E. 26th St.
Buffalo: 957 E. Ferry St.

STEWART SEWER CLEANING MACHINE

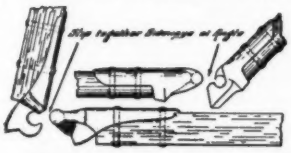
Water Cleaning System, if you wish it, or Drag Bucket type.

Also have TURBINE SEWER CLEANING MACHINE at Low Price.

WE WILL PAY FREIGHT AND CHARGE TO BILL.

We Ship Rods for Trial—who else will do this?

We also make a Rod that will float. Also Rods with wheels for conduit work.



SEWER AND CONDUIT RODS

No Deep Shoulder Cut for Couplings. Rods retain full size and strength.

Investigate our JUMBO ROD

W. H. STEWART

1614 Locust Street . . ST. LOUIS, MO.
129 George Street . . BOSTON, MASS.

CANADA FACTORY, WALKERVILLE, ONT.
Therefore No Duty for Purchaser to Pay.

PACIFIC COAST DELIVERIES MADE FROM SAN FRANCISCO.

CUT that NEXT JOB with a

STRICKLER

Ratchet Pipe Cutter

Cuts either Cast or Steel pipe. Cuts a channel in the pipe same as a lathe cut.

Each size cuts a range of sizes. Catalog on request.

W. W. STRICKLER & BROS.
COLUMBUS, OHIO.

American Cast Iron Pipe Company

Manufacturers of

BIRMINGHAM, ALA.

Sales Offices:

Birmingham, Ala. . . . . Box 908
Columbus, Ohio . . . 607 New Hayden Building
Minneapolis, Minn. . . . 712 Plymouth Building
New York City . . . . . No. 1 Broadway
Chicago, Ill. . 512 First National Bank Building
Dallas, Texas . . . . 1217 Praetorian Building
Kansas City, Mo. . . . . 716 Scarritt Building
San Francisco, Cal. . . . . 711 Balboa Building
Los Angeles, Cal. 339 Citizens National Bank Building

of so slight a specific gravity that it will never settle. I do not refer to the thick viscous sludge appearing at the top of the gas vents and which may be wheeled off in wheelbarrows, but to a sludge of 95 per cent. water content and thoroughly digested. This sludge floating throughout the entire depth of the digesting compartments and gas vents is naturally carried back, via the slots, to the settling compartment by various currents. The result is a black film on the surface of the settling compartment and a very poor looking effluent, with an avidity for oxygen, which is a serious drain on the sprinkling filter.

It now appears that it will be necessary to pump out the upper portions of the digesting compartments at least once a year, in order to dispose of this digested but unsettleable sludge.

Sludge Drying.

With regard to sludge drying, we find that with 35,000 connected population we have approximately 4,000 cu. yds. of sludge to be removed from the tanks each year.

Our experience shows that it is not economical to put over 9 ins. of wet sludge on a bed, since this quantity will dry in a week or ten days of good weather, while any greater quantity will require a time measured in weeks.

It is surprising to find that, in spite of the fact that a coat of sludge 9 ins. thick will become spadable in a week or ten days of good drying weather, under actual climatic conditions we have averaged only a scant 6 dryings per year. The figures for three years being 5.8, 6.0 and 5.8 dryings per bed per year.

Therefore to dry 4,000 cu. yds. or 108,000 cu. ft. of sludge per year requires 108,000÷75=144,000 sq. ft. of drying surface per year. And 144,000÷6=24,000 sq. ft. drying area required to take care of 35,000 people under local weather conditions. This amounts to 0.686 sq. ft. per person.

Operating Costs.

Operating costs outside of supervision and organization charges are shown in some detail for 1920. It would hardly be worth while to go into operating costs for the other three years on account of the sliding scale value of the dollar, but the proportional distribution will be very nearly the same as for 1920.

It is interesting to note that outside of interest charges the comparative costs as between screening and removing the objectionable solids from the tanks by hand are just about equal. That is to say, the time now spent by a watchman on the screen and the cost of power about equal the cost of labor in removing the coarse solids. The plant, however, is much more "workable" and the nature of the labor much less objectionable when the solids are removed before reaching the tanks.

Outside of the "Imhoff" tanks and the Wurl screen, which, in view of the above statement, must be considered as a charge against the tanks, one man could do all that is necessary about the plant. To this other work we will suppose the highest paid laborer to be assigned and charge all ordinary labor to care of screens and tanks to sludge removal.

Cost of Operation, 1920

	Total	Chargeable to screens, tanks and Sludge removal
Labor	6437.66	4637.66
Heat, light, power, etc.	1131.39	240.00
Supplies, tools	1017.59	1017.59
Machine repair tractor, spreaders, etc.	247.05	247.05
Screen motor repair	186.28	186.28
Gasoline, oil, etc.	370.80	370.80
	9390.77	6699.38

Expressed in man hours, the labor required to operate the plant is:

For general attention to plant 2,450 man hours per year.

For night watch on screen, 5,630.

Care of tanks, 5,820.

Drawing and hauling sludge, 1,242.

Or general plant, 8 hours week days.

Watch on screen at night, 16 hours week days and Sundays.

Care of tanks, 17 hours week days.

Drawing and hauling sludge, 4 hours week days.

Screen Maintenance.

The screen has run practically continuously for two years. The first set of screen cleaning brushes lasted exactly two years before requiring replacement. The speed control apparatus on the motor is the only thing that has given any trouble; $151.01 has been expended to date on this item. Two broken brush flanges, cost for replacement and a duplicate of each for stock, $38. The current consumption is from 9 to 12 k. w. h. per day.

The maximum (working) loss of head on the screen is 13 ins., and the capacity of the screen, with 13 ins. loss of head and full screen speed (about 1 r. p. m.), is at the rate of 4,750,000 gals. per day.

Engineers' and Contractors' Directory

JOHN W. ALVORD :: CHAS. B. BURDICK
Consulting Engineers
Water Supply Sewerage Water Works
HARTFORD BUILDING, CHICAGO, ILLINOIS.

FARGO ENGINEERING CO.
ENGINEERS
Water Supply. Steam and Hydraulic Power Plants. Advice as to Reduction in Operating Costs. Reports and Estimates for Bond Issues.
212 W. Cortland St. Jackson, Mich.

Wm. Artingstall
Civil Engineer
WATER SUPPLY SEWERS SEWAGE DISPOSAL
Old Colony Building Chicago

WALTER H. FLOOD & CO.
PAVING LABORATORIES
Plant and Street Inspection. Testing and Inspection of Materials.
Offices: 22 Quincy St. Laboratories: 742 E. 39th St.
CHICAGO, ILL.

CHAS. BROSSMAN
CONSULTING ENGINEER
Water Supply. Sewerage and Disposal. Lighting Plants—Supervision of Construction and Reduction in Operating Cost. Appraisals—Expert Testimony.
Merchants Bank Bldg. INDIANAPOLIS, IND.

Nicholas S Hill Jr S. F. Ferguson
HILL & FERGUSON
CONSULTING ENGINEERS
WATER SUPPLY—SEWAGE DISPOSAL—HYDRAULIC DEVELOPMENTS.
Reports. Investigations Valuations Rates. Design Construction Operation. Management. Chemical and Biological Laboratories.
112 E. 19th Street New York City

BURD & GIFFELS
CIVIL ENGINEERS
POWER DEVELOPMENTS WATER SUPPLY SEWERAGE
KELSEY BUILDING GRAND RAPIDS, MICH.

J. W. HOWARD
CONSULTING ENGINEER
ROADS AND PAVEMENTS
Laboratory Analyses and Tests. Specifications improved.
Expert in Valuation and Litigation. 32 years' experience.
1 Broadway NEW YORK CITY

CHICAGO PAVING LABORATORY
L. Kirschbraun H. W. Skidmore
CONSULTING and INSPECTING ENGINEERS
PAVEMENTS and PAVING MATERIALS
Consultation, Design, Specifications, Reports, Testing, Inspection and Research.
160 North Wells Street CHICAGO

ROBERT W. HUNT & CO., Engineers
Inspection — Tests — Consultation
PAVING MATERIALS, CAST IRON PIPE, STEEL AND CEMENT
Chemical Cement and Physical Laboratories
2200 Insurance Exchange CHICAGO, ILL.

CITY-WASTES DISPOSAL CO.
(Organized from Staff of Col. Geo. E. Waring, Jr.)
Consulting Engineers. Specialists in Drainage, Sewerage and Sewage Disposal. Preliminary Investigations and Estimates, Surveys, Plans and Supervision. Sanitary Examinations and Reports.
45 Seventh Ave. NEW YORK.

SAM L. JONES, Consulting Engineer
PAVEMENTS and ROADS
Specifications, Estimates and Cost Systems
807 Second Nat'l Bank Bldg. CINCINNATI, OHIO

DOW & SMITH
CHEMICAL ENGINEERS
Consulting Paving Engineers
A. W. DOW, Ph. B., - Mem. Amer. Inst. Ch. Engrs.
F. P. SMITH, Ph. B., - Mem. Amer. Soc. Civil Engrs.
Asphalt, Bitumens, Paving, Hydraulic Cement, Engineering Materials
131-3 E. 23rd Street NEW YORK CITY

W. G. KIRCHOFFER
Sanitary and Hydraulic Engineer
Water Supplies Water Purification Sewerage Sewage Disposal Land Drainage
22 N. Carroll St. MADISON, WIS.

DAVID MACNAUGHTON
CONSULTING ENGINEER
ELECTRIC AND WATER UTILITIES
Appraisals, Reports, Investigations, Valuations, Rates and Design Construction.
Central Building FORT WAYNE, IND.

ALEXANDER POTTER, C. E.
HYDRAULIC ENGINEER AND SANITARY EXPERT
50 Church St., New York City
Sewerage and Sewage Disposal, Water Supply and Purification, Water and Electric Power.
Valuations of Existing Plants where MUNICIPAL OWNERSHIP is Contemplated—Expert Testimony—Plans and Estimates.

ASTRID S. ROSING, Inc.
Sewer Pipe—Drain Tile—Steam and Electric Conduits—Building Tile—Fire Brick
Harris Trust Building, CHICAGO, ILL.

W. S. SHIELDS
CONSULTING ENGINEER
Municipal Improvements. Water Supplies and Water Works Systems. Sewers and Sewage Disposal. Pavements and Roads.
Hartford Building. CHICAGO, ILL.

HERMAN STENSRUD
MARQUETTE, MICHIGAN.
Trenching for Water Mains, Shallow Sewers or Drainage, by lineal foot or by day.
Machine—Buckeye, gasoline driven, cutting two feet by six feet.

SULLIVAN, LONG & HAGERTY
GENERAL CONTRACTORS
Builders of Sewer Systems and Water Works Plants
Home Office, BESSEMER, ALA.

Testing, Consultation, Bitumens, Paving, Inspection, Specifications, Asphalts, Road Oils.
ISAAC VAN TRUMP
ENGINEERING CHEMIST
2337 South Paulina Street. CHICAGO, ILL.

JAMES P. WELLS, HYDRAULIC ENGINEER
Surveys, Estimates of Cost of Proposed Work, Reports on New Improvements, Preparation of Plans, Supervision of Construction, Dams and Reservoirs, Pipe Lines, Filtration Plants, New Water Supply Systems, Hydro-Electric Power Plants.
Main Office, 249 Cutler Bldg., Rochester, N. Y.
Chicago, Ill. New York City. Knoxville, Tenn. Toronto, Ont.

CHLORIDE OF LIME
FOR PURIFYING WATER
PENNSYLVANIA SALT MANUFACTURING CO.
Widener Building PHILADELPHIA, PA.

BEST EXTENSIBLE TRENCHING BRACE MADE
KALAMAZOO F'DRY & MACHINE CO. MICHIGAN
594 EAST MAIN ST.

SLUICE GATES
Sheer, Flap and Butterfly Valves
FLEXIBLE JOINTS
COLDWELL-WILCOX CO.
South Water St. NEWBURGH, N. Y.

FOR SALE!
One Concrete Mixing Plant. All steel construction. Large Bins: Tar and Asphalt Heaters on wheels; Conveyors. Thirty h.p. Portable Boiler and Engine on wheels. Sold with or without power.
Plant located in Eastern Pennsylvania.
Also—Oil Pull Tractors, new and used; sizes, 12-20-16-30 20-40-30-60. Address
B. D. REED MACH. CO. N. S., Pittsburgh, Pa.

DIRECT OXIDATION PROCESS
Apparatus for carrying out this Process for Sewage and Water Treatment supplied upon Engineers' specifications.
DIRECT OXIDATION PROCESS CORPORATION
15th and Lehigh Ave. PHILADELPHIA, PA.

VALVES & FITTINGS — FLOWER COMPANY — DETROIT, MICH.
DETROIT FILTRATION PLANT LARGEST IN THE WORLD
FLOWER HYDRAULIC AND HAND OPERATED VALVES, SLUICE GATES, SPECIALS, ETC., ASE USED THROUGHOUT THIS SIX MILLION DOLLAR PLANT.

STANDARD AND HIGH PRESSURE FIRE HYDRANTS	CAST IRON, STEEL AND BRASS VALVES
SLUICE GATES	FILTRATION SPECIALS
TAPPING VALVES AND SLEEVES FOR WATER AND GAS TAPPING MACHINES	CAST IRON AND STEEL FITTINGS
FABRICATED STEEL PIPE	GRAY IRON CASTINGS

Construction News and Equipment

THE CARE OF CONCRETE MIXERS

By L. P. Lessard, Sales Department, The T. L. Smith Co., Milwaukee, Wis.

If contractors would give their concrete mixers the little attention that they require, they would last much longer. In most cases the operators are fully responsible for the upkeep of the machines and are never called to task because the mixer is in run-down condition. If the contractors themselves or a responsible foreman would see to it that their mixers were properly greased, oiled, cleaned, etc., there is no doubt that the mixer's life and efficiency would be materially increased.

Many building contractors do look after their mixers and their machines reflect this care in their operation. However, workmen usually leave their mixer just as they finish with it. Only recently the writer saw two workmen one morning pounding the loading skip with sledge-hammers, trying to clean it out, because they had neglected to wash it out the previous evening. Imagine the mixer going through this pounding process every morning and possibly more frequently. No wonder the mixer lasts only a short time and needs to be replaced.

The following suggestions for taking care of building mixers are intended as an aid to those contractors who do not, but should, give their mixers careful attention. If followed carefully, good results will be noticeable in the looks and operation of the mixer.

Setting Up

When you buy a new mixer, see that it is assembled correctly before starting. Turn down the grease cups, oil the wearing surfaces where necessary, see that the bolts and nuts are tight, and be sure everything is all right, then go ahead. Manufacturers always send instructions for setting up, which should be your guide when assembling.

Oiling

Oil your machine liberally. Give the drum rollers plenty of grease; they have the heaviest duty. Don't forget your engine, either; it needs oil. Follow the engine oiling instructions carefully. Oil the drive chains to make them drive smoothly and endure. Oil all gears, especially bevel gears. Use a good quality of machine oil that will not thicken when cold. Also, use a good grade cup grease where grease is required.

Feeding

It has been found that as far as mixing is concerned, it does not matter in what order materials are fed into the drum. The feeding is done to meet the convenience of the operator. If desired, the old method of hand mixing can be adopted, as follows: Sand and cement, then add water and follow with crushed rock or gravel. A good way to get cement in without "dusting" is to put it into a barrow of sand, or, still better, to add some water to the batch before putting in the cement.

Where a sharp stone is used in the batch, it is well to put in a portion or all the sand first, as the sand will act as a cushion and protect the shell of the drum.

Do not fill the drum too full. A big batch mixes more slowly than a small one. There is a happy medium between best time per batch and best quality, which experiment will determine. Cement mortar or "sloppy" concrete is best mixed in batches of reduced size.

Washing

Wash out the drum before the mixer is stopped. It is necessary to keep the inside of the drum clean, as only a clean drum will do good work. Fill the drum with water and revolve until it is clean, then discharge the water. If water alone does not clean the drum, add a little crushed stone or a few small pieces of scrap iron.

If the drum is once neglected and cement allowed to harden inside, it is very difficult to clean.

Blocking

It is sometimes desirable to block mixers. Do this whenever possible. It not only prevents destructive vibration, but saves power and repair bills.

Care of Boiler

If you have a steam-driven mixer, follow these instructions carefully. Do not fire hard when the boiler is cold. The type of vertical boiler best adapted to concrete mixers has one weak point, viz., the top ends of the flues are not surrounded by water. In raising steam, the

fire should not be crowded until some pressure is shown on the gauge, or the top of the tubes, will be overheated and the boiler will surely leak.

A boiler is really a sensitive apparatus and requires as much or more attention than the engine.

Repairs

Keep your mixer repaired. Don't allow parts to be worn so they affect the operation of the mixer. The minute you notice a worn part order a new one. It will pay you every time. Particularly watch your drum rollers. Replace them as soon as they are worn or become wabbly. Never allow your drum to run untrue. Watch every part and replace it with new one as required.

Ordering Repairs

Always keep the repair lists which the manufacturer furnishes. Order your parts by numbers or according to the factory instructions. You would be surprised how much time it will save, and the sooner you get the replacement part on your mixer the better for the mixer.

These simple rules, if followed carefully, will apply to any make of mixer. As a rule, manufacturers furnish instruction books which go into detail on each item, but if contractors will follow the above rules and use their own judgment about oiling, loading and taking care of their mixer, they will find that their mixer will give them better service and last much longer.

PERFORMANCE OF TRACTOR AND WHEEL SCRAPER OUTFITS ON DIXON-HENDERSON ROAD, WEBSTER COUNTY, KY.

By W. B. Hill, Jr., The Holt Manufacturing Co., Inc., Peoria, Ill.

In grading the Dixon-Henderson Road in Webster County, Kentucky, Mr. Mitchell, of Townsend, Mitchell & Carter, Contractors, is using two trains of tractor-drawn wheel scrapers consisting of two 5-ton Holt "Caterpillar" tractors, and four Maney four-wheel scrapers. This method of moving dirt is about a year old, and everywhere it has been tried out has effected for the contractor a consideramle saving over grading with teams.

The Dixon-Henderson Road is a Federal Aid Project forming part of the Dixie Bee line running from Chicago to Florida. The section under construction (Project 39, Sect. C) is about 5 miles long, and winds around the Kentucky hills with few level stretches, and with grades of from 2 to 6 per cent.

The contract calls for moving about 35,000 yds. of dirt, putting in some 20 concrete culverts, and clearing and grubbing about 2½ acres of ground. Free haul is 500 ft. with an overhaul of about 13,000 ft. on 5,000 yds. Character of soil is lime stone clay, free from rock.

Work was started in September, 1920, with teams alone. Operations were stopped for the year on December 17th. During the last month and a half, "Caterpillar" tractors and scrapers were used, replacing all except 4 teams. In 1921 work was begun on April 4th, with the same equipment (tractors, scrapers and 4 teams).

Method of Operation

The method of operation is to use the "Caterpillar" tractors on hauls of 150 ft. and up, and teams and slip scrapers on all of the shorter hauls. This forms an ideal combination, and gives the contractor an equipment so flexible and efficient that he can handle any given condition with maximum economy.

The efficiency of teams is well known on hauls of around 100 ft., on hauls across the road, knocking down short, steep banks, filling up deep holes and washouts, etc. But where teams begin to cost real money is on the longer hauls.

It is this condition that the "Caterpillar" drawn wheel scrapers handle best. The following are typical examples of the amount of dirt these outfits have moved: Working up and down a 6 per the corners when the flow was sluggish. cent. grade that was to be cut to 5 per cent., on an overhaul of about 1,300 ft., Mr. Mitchell found that one "Caterpillar" outfits gave him 400 yds. per 10-hour day.

The power units consist of two 5-ton "Caterpillar" tractors hauling 2 scrapers apiece. Six men are employed as operators; 2 on the tractors, and 1 on each of the 4 scrapers. On hauls of around 20 yds. one power outfit loads 180 yds. from the fill; second outfit 220 yds. from fill. This prevents delays. On longer hauls this is unnecessary. The road is about 24 ft. wide, which gives ample room for passing at any point. The "Caterpillars" turn the scrapers easily within this radius, and when necessary can turn within 18 or 20 ft. In going over or turning on soft fills, up grade, or through mud, the "Caterpillars" have ample power to pull the scrapers. In fact, Mr .Mitchell handles all of his trac-

KOEHRING

Look under the drum!

IF it is a Koehring mixer, you will see that the heavy drum is supported by drum rollers, constructed on freight car truck principle. The drum rollers do not turn on a fixed axle, which under the down thrust of heavy drums soon must wear flat on the top side and set up pounding vibrations throughout the mixer. No—the rollers which support the Koehring drums are fixed to shafts which turn in big bearings easily accessible on the main frame! There's a simple, accessible, easily lubricated, long-life construction, right there at a point of greatest strain and wear. But it is only one of the better construction features which make Koehring the *Heavy* Duty Mixer.

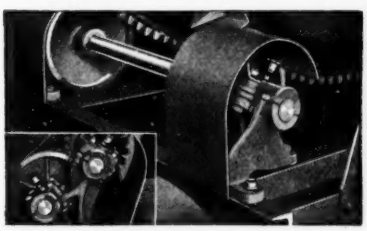
CAPACITIES

Pavers: 10, 14, 21, 28 cu. ft. mixed concrete, steam or gasoline, multiplane traction, loading derrick, power discharge chute.

Construction Mixer: 10, 14, 21, 28 cu. ft. mixed concrete, steam and gasoline, power charging skip, batch hopper.

Dandie Light Mixer: 4 and 7 cu. ft. mixed concrete, low charging platform, power charging skip, light duty hoist.

Write for Bulletin P-10.



The above shows the heavy brackets, mounted on the main frame on which are mounted the extra big bearings in which turn the drum roller shafts. Notice that the bearings are at an angle which brings the load on the full face of bearing. These bearings are extraordinarily long, and easily accessible for lubrication or re-babbitting.

KOEHRING COMPANY, MILWAUKEE WISCONSIN

MADE RIGHT IN MILWAUKEE PRODUCT

In writing to advertisers please mention MUNICIPAL AND COUNTY ENGINEERING

tor operations on direct gear, rarely if ever using low gear of the tractor, which gives approximately twice as much power. One scraper man is generally used to handle a train of 2 or 3 Maneys behind a 5-ton "Caterpillar," but Mr. Mitchell has found it better economy to use 1 man on each scraper for the following reasons:

They take better care of the scrapers and geep them in better order; they take a great interest in their particular scraper; they like job because seat is very comfortable and work is not hard; they can get a bigger load per trip; they can make a smoother, more even cut; they are a great help in the morning, speeding up work of greasing tractor and scraper wheels; they provide an extra man for an emergency; they cost little. With dirt paid at the prevailing rate, and the extra operator getting $3, a few more yards of dirt pays his daily salary.

Start Work Quickly After a Rain

After a rain operations can be resumed very quickly on account of the track laying construction of the "Caterpillars," which gives them a firm footing over soft ground. A thin cut is made to take off the top layer of mud. The sub-soil then encountered is dry, and there are no further difficulties. Plowing is unnecessary except in one or two cases; notably when making deep cuts of from 7 to 10 ft, it is sometimes necessary to plow through the very hard clay found at this depth.

Before starting on any particular section, the stakes are taken out and set on one side of the road. Particular attention is paid to getting down to grade on the crown; the sides being later finished with an 8 ft. blade grader pulled by one of the "Caterpillars.'

Mr. Mitchell has found that his four teams are particularly useful in smoothing out the road ahead of his wheel scrapers. For example, on coming to a gully, some 30 ft. wide with nearly perpendicular banks about 8 ft. high that crossed the right-of-way, he worked his teams with slip scrapers all day, filling in the bottom and plowing the banks down somewhat. When he had made roughly a 25 per cent. grade out of the banks, he moved his teams up farther ahead and put his "Caterpillars" and Maneys to work on the fill. As the two outfits dump 4 full yds. on every trip, the remainder of the fill was made in a short time. Such obstacles as trees, hedges, stumps and heavy roots are either dragged out by the "Caterpillars" or chopped out by hand. The contractor is doing his own concrete work, and is using a small one bag mixer. The equipment used is as follows:

Equipment

Two 5-ton "Caterpillar" tractors; 4 Maney four-wheel scrapers; 4 No. 2 slip scrapers; 1 plow; 1 Blade grader (8 ft.); 1 Dodge touring car; 1 International truck; 1 concrete mixer (1 bag); 75 ft. of chain, ⅝ in.; and small tools.

Personnel

One contractor; 2 tractor operators; 4 scraper operators; 4 mule team drivers (hired with teams); 1 dumpman; 1 roustabout; 1 man for clearing right-of-way; 1 loader (for teams); 1 truck driver; 1 concrete mixer foreman; and 5 laborers on mixer.

Herewith is given a table of capacities showing amount of dirt the 5-ton "Caterpillar" has moved daily, hauling 2 and 3 Maney scrapers respectively.

DETAIL TIME TABLE FOR 5-TON "CATERPILLAR" PULLING TWO 4-WHEELED SCRAPERS.

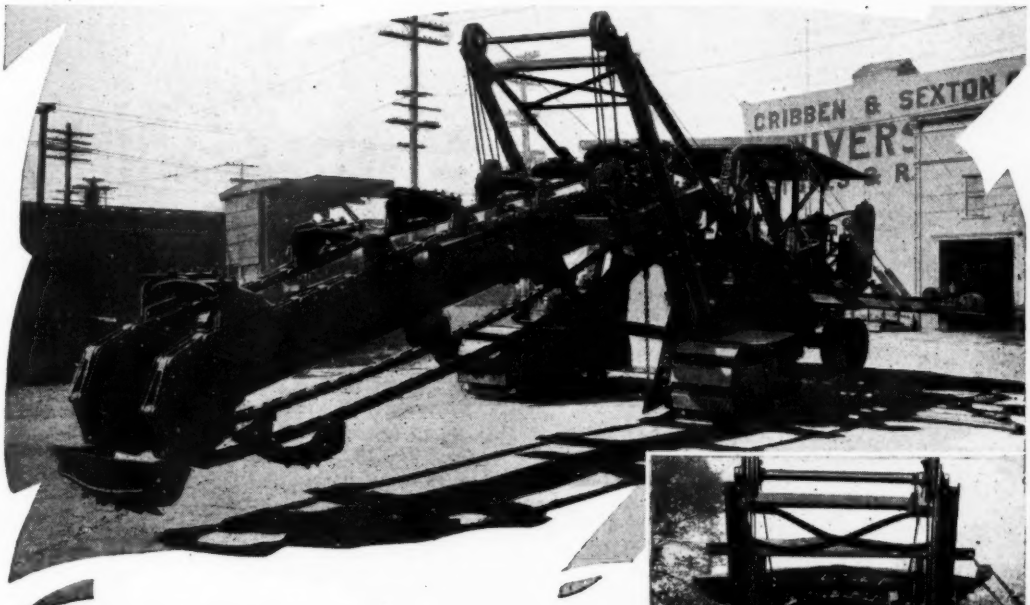
Length of haul in feet	300	600	900	1320	1800	2640
Round-trip time, hrs. and min.	3:55	5:35	7:25	9:50	12:25	17:25
Cubic yards per trip	2	2	2	2	2	2
Cubic yards per 10-hr. day	262	214	160	122	96	68

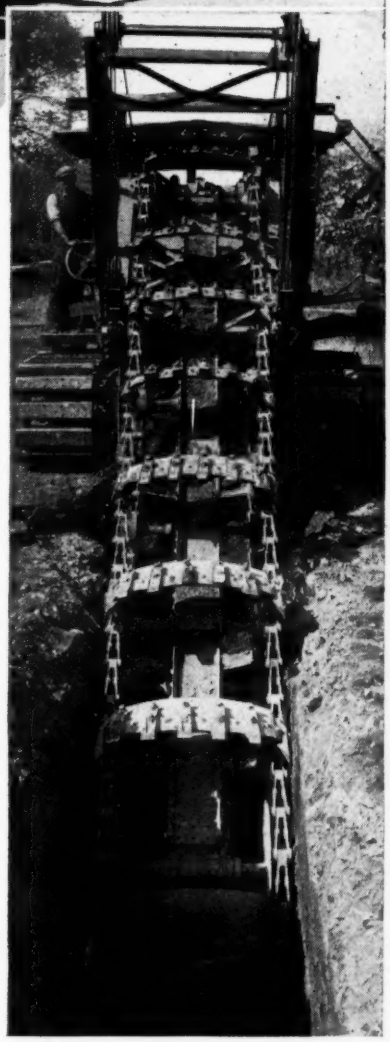
DETAIL TIME TABLE FOR 5-TON "CATERPILLAR" PULLING THREE 4-WHEELED SCRAPERS.

Length of haul in feet	300	600	900	1320	1800	2640
Round-trip time, hrs. and min.	4:45	6:10	8:10	10:35	13:20	18:10
Cubic yards per trip	3	3	3	3	3	3
Cubic yards per 10-hr. day	360	270	210	150	120	90

Note.—The above calculations are based on round trip times that include over 15 per cent. for lost time, or more than 1½ hours per day. The table is not intended to show an absolute or guaranteed daily yardage. It was made from operations run under average conditions on level ground, and shows results that may be expected if the outfit is efifcient-ly handled.

Page 28 shows dynomometer record of 5-ton "Caterpillar" pulling 3 Maney four-wheel scrapers, which was taken February 15, 1921, through rolling field. Soil,





Coming Events Cast Their Shadows

Mother Earth fairly trembles at sight of the buckets with their sharpened steel teeth ready to bite a deep trench at the will of the one operator who controls this earth-eating monster.

Big, though it is, every part is carefully and thoroughly made. Every steel plate and girder is rolled before riveting—one reason for its resistance to side strains. In action or idle it is a machine that the engineer is glad to inspect.

And close inspection reveals the reasons for the greater digging capacity and the low maintenance costs. It also shows why the initial cost is more, and why it it the lowest in cost for a given period of years.

Bulletin IX describes wheel type excavators as well as the latest ladder type illustrated above. Write for a copy today.

EXCAVATING MACHINERY DIVISION

PAWLING & HARNISCHFEGER CO.

In Milwaukee, Wisconsin, since 1884

New York, 50 Church Street
Philadelphia, Stephen Girard Bldg.
Pittsburgh, Fidelity Bldg.
Chicago, Monadnock Block
New Orleans, Whitney Central Bldg.
San Francisco, Monadnock Bldg.
Los Angeles, Central Bldg.
Seattle, L. C. Smith Bldg.
Portland, Yeon Bldg.
St. Louis, Blackman-Hill-McKee Mach. Co.
Birmingham, C. B. Davis Eng. Co.
Salt Lake City and Denver, Landes & Co.

and Agents in 16 Cities.

POUNDS PULL ON DRAWBAR.

	Maximum	Average
Loading first scraper	6,200	4,960 at 1½ miles per hr.
Loading second scraper	5,800	4,520 at 1½ miles per hr.
Loading third scraper	6,000	4,800 at 1½ miles per hr.
Hauling loaded scrapers—		
	Maximum	2,800 at 3 miles per hr.
	Minimum	1,600 at 3 miles per hr.
	Average	2,140 at 3 miles per hr.
Dumping—		
	Maximum	3,100 at 3 miles per hr.
	Minimum	1,800 at 3 miles per hr.
	Average	2,540 at 3 miles per hr.
Turning empty—		
	Maximum	1,360 at 3 miles per hr.
	Minimum	960 at 3 miles per hr.
	Average	1,160 at 3 miles per hr.
Returning—		
	Maximum	1,500 at 5.71 miles per hr.
	Minimum	500 at 5.71 miles per hr.
	Average	928 at 5.71 miles per hr.

(*) Note.—The pounds pull on drawbar required to load first scraper is higher than that required to load second and third, because scraper operator took an extra deep bite with his pan and took up a load greater than 1 cu. yd.

medium damp clay, showing all phases of operation within guaranteed drawbar horse power of the tractor.

From costs on four months time already put in on the contract, Mr. Mitchell figures that his "Caterpillar" tractor outfit shows him a saving of from 20 to 25 per cent. over the cost of doing the same work with teams. His outfit is so flexible that it can be efficiently applied to any conditions likely to be encountered without loss of time and in the most economical way.

PROFITABLE ADAPTATIONS OF AN EXCAVATOR AND LOADER IN PITS AND QUARRIES

In the sand pits of the Belt Line Brick Co., Minneapolis, an interesting "two-man-machine" has been doing the work of 20 to 30 laborers daily.

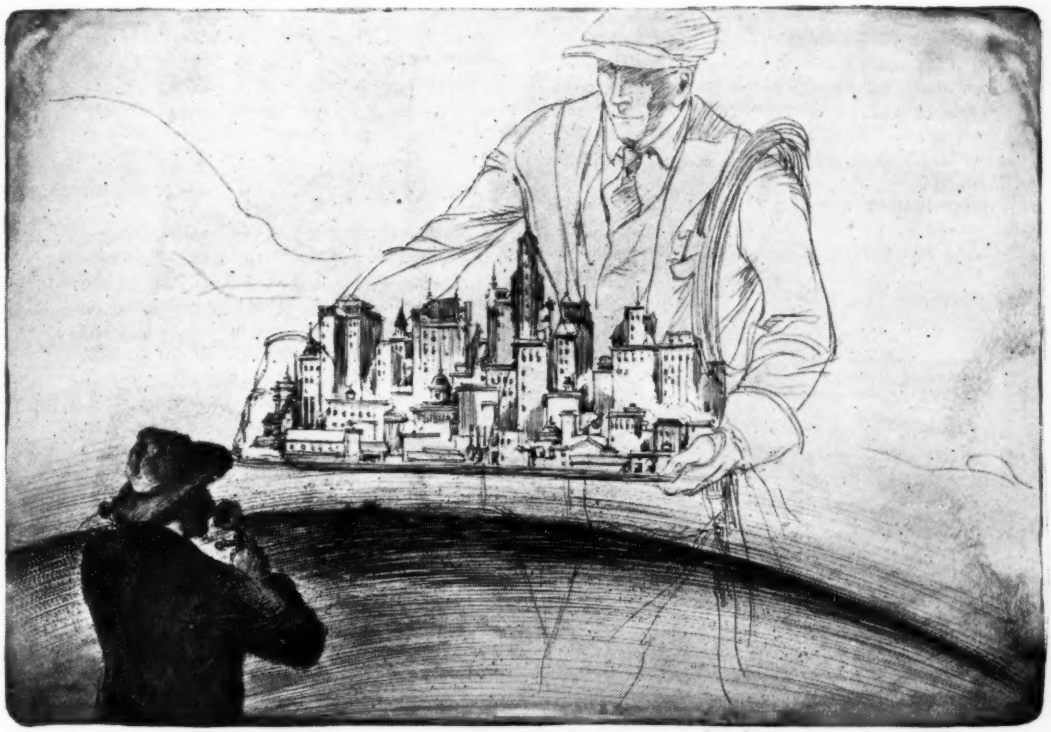
In Minnesota Sand Pits

At the edge of the sand pit, as shown in the illustrations, two sets of tracks were laid. One was a narrow-gauge, over which industrial cars were hauled. The other track had a gauge of about 18 ft. and carried a wide, four-wheeled truck, on which had been mounted a Smith excavator and loader. The two sets of tracks were parallel, arranged so the machine could load directly into the cars of the industrial train.

Each car holds about two loads from the machine, which digs the sand and loads it into the cars, with only two men on the job. When necessary to move the digging point in the pit, the truck on which the excavator was mounted was merely rolled along its track to the desired position.

The machine is a portable dragline excavator and loader, ordinarily mounted on its own trucks and designed so it can be

SMITH EXCAVATOR AND LOADER WORKING AT GRAVEL PIT FOR ST. LOUIS COUNTY, MINN.



Bring Me A City!

Heeding no barrier of river, mountain, forest or desert; unmindful of distance; the telephone has spread its network of communication to the farthest outposts of our country.

The ranchman, a score of miles from his nearest neighbor, a hundred miles from the nearest town, may sit in the solitude of his prairie home and, at will, order the far-distant city brought to him. And the telephone obeys his command.

Time and space become of small account when, through desire or necessity, you would call across a continent.

This is what the "Long Distance" service of the Bell telephone has accomplished for you; what science in construction has created; and what efficiency of workers has maintained.

You take the telephone as much for granted as you do the wonder of the changing seasons. You accept as a matter of course the company's ability to keep all the parts of this great nation in constant contact.

By so doing you offer a fine tribute to the Bell organization which has created this "Long Distance" service—a service no other country has attempted to equal.

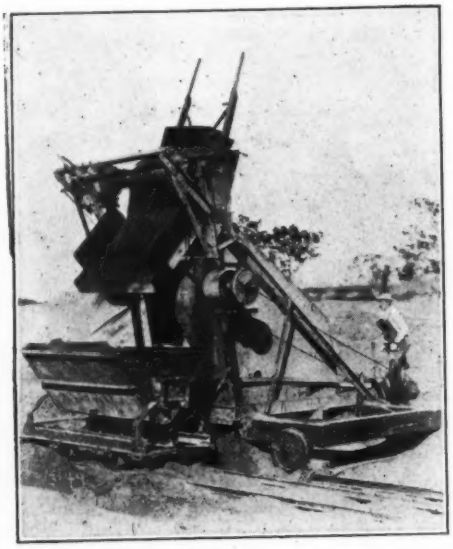
AMERICAN TELEPHONE AND TELEGRAPH COMPANY

AND ASSOCIATED COMPANIES

One Policy *One System* *Universal Service*

And all directed toward Better Service

hauled by a team or motor truck from one location to another. It operates a digging slip or scraper similar to the ordinary horse-drawn scraper. This scraper digs in a radius up to 100 or 150 ft. from the machine. One man guides the scraper while it digs. When full, the scraper is hauled up to the machine unattended. The loaded scraper then rides into the pivoted arms of the excavator, which elevate it over the machine and the load is dumped into the waiting cars. One man operates the machine; one man guides the scraper.



SMITH EXCAVATOR AND LOADER LOADING SAND INTO INDUSTRIAL CARS.

Two hundred and fifty yards of sand per day was an easy average day's work for two men on the Belt Line Brick Company's pit.

The above adaptation of the Smith excavator and loader was unusual only in that the machine was mounted so as to run on rails, as explained above. Ordinarily the machine, on its own trucks and wheels, would be placed at any convenient spot, on solid ground, near the pit or excavation or material pile on which the work was to be done.

The fact that the machine itself works on solid ground and never has to get into the hole, is an important feature. Steam shovels and other excavating devices have to work in the hole. They have to load their wagons, trucks or cars in the hole. But the Smith excavator loads its wagons, trucks or cars on solid ground or up on their regular tracks, in the case of cars, and for that reason full loads can be taken each trip. At the same time there is no necessity for using snatch teams where the Smith excavator is working, as is necessary with steam shovel work, to help haul even the lighter loads out of the hole.

As Used by a Chicago Sand and Gravel Producer

A sand and gravel producer in Chicago, the H. Bairstow Co., found that an average of 50 per cent. more was hauled on each load when using this excavator as compared with loads that had to be hauled out of the hole when using a steam shovel. Quoting Mr. Bairstow: "We now load 3 cu. yds. to a load from the excavator. Formerly we could not average 2 cu. yds. while making a 9-ft. sand excavation. The excavator handles from 300 to 350 cu. yds. (wagon measurement) per day. The saving in horses would more than equal the cost of operating this machine." And he reports also that 2 men with this machine eliminated 15 laborers, 1 foreman and 3 snatch teams.

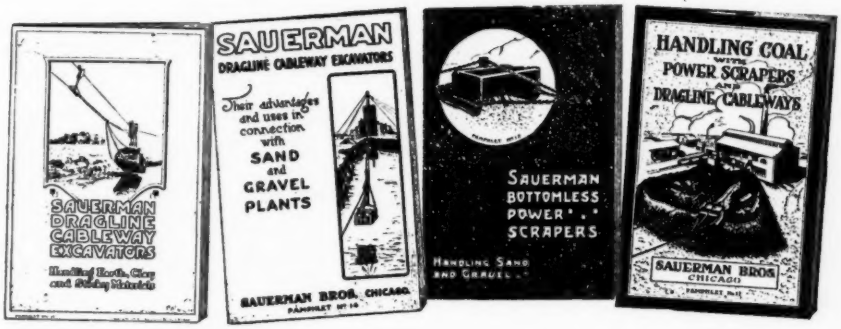
Another interesting feature of this machine and the fact that it remains out of the hole, on solid ground, is that when a job is finished, the machine is easily hauled away without any preliminary preparations or waste of time. There is no planking, blocking out or hoisting to be done. A team is hooked on, or a motor truck, and the excavator is moved to the next job as easily as if it were an ordinary wagon.

As Used by an Arkansas Gravel Producer

In Arkansas, the Benton Gravel Company, of Benton, used one of these Smitth excavators in their gravel pit. Their pit was a tough one for any machine work. They were getting out road ballast, which was formed in the pit almost as hard as concrete. This problem was easily solved by attaching a strong plow to the dragline cable in place of the digging slip, or scraper, and thus using the machine's power to break up this hard material. After breaking the surface with the plow, the scraper was again attached to the cable and the digging and loading was easy. The machine, in this case, was placed at the freight cars, so that the gravel was hauled in the scraper out of the pit and loaded directly into gondolas at a big saving of time and labor. Two men averaged 35 yds. an hour on this difficult work, according to H. J. Archer, manager of the Benton Gravel Company.

This machine can be adapted to many phases of digging and loading problems where heavy machinery is impracticable

Which of these Booklets do *You* Want?



Pamphlet No. 15 gives details and illustrations of the various types of dragline cableway excavator installations that interest engineers, dirt-moving contractors and clay plant owners.

Pamphlet No. 14 is a handy compilation of data on the dragline cableway excavator method of excavating and conveying sand and gravel, illustrated with many views of typical installations.

Pamphlet No. 12 describes the latest developments in the use of mechanical drag scrapers for handling gravel from hillside, and explains the adaptability of power scrapers for small pits.

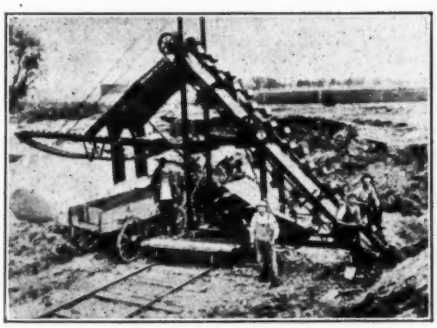
Pamphlet No. 11 illustrates practical solutions of various coal storage problems by use of scrapers and dragline cableways, some of this data being now published for the first time.

We invite your request for any or all of the above booklets.

SAUERMAN BROS., 1142 Monadnock Bldg., **CHICAGO.**

The Michigan Jr. Gravel Screener and Loader

Takes Gravel out of Pit or Pile, Screens out Sand and Stones and Loads the Gravel into Wagons or Trucks.



Calhoun County (Mich.) owns *four* machines, and contractors own *three* others, making *seven* in one county.

The Michigan Jr. holds the low record of cost of handling screeded gravel from pit to wagon or truck. This is the all-important consideration, Mr. Contractor. This saving is your profit.

Machine runs up and down side of pit or pile on a track and takes off slice of about ***four*** ft. each time. After going along track once, track is moved over and loader returned along side of pit or pile.

The Screener and loader is self-contained, furnishing own power, and has attachment on screen that prevents clogging with clay, clods, etc.

Machine has elevating capacity of ***one yard per minute,*** and the only operating expense is salary of three men, under ordinary conditions. One operates machine and two break down embankment.

Sand and stone are conveyed 20 ft. away and do not have to be moved. Machine moves under own power. Easily moved from one pit to another. It is all steel, engine enclosed. ***Saves $30 to $50 a day*** in expenses and makes money in handling gravel.

For further particulars write to

THE JORDAN & STEELE MFG. CO., Inc.

CHARLOTTE, MICHIGAN

and hand labor is too slow and costly. Excavating cellars or basements for buildings, loading coal, stone or other materials at yards, for heavy plowing, digging and loading sand and gravel, grading or excavating alleys, streets and roads, cut-and-fill work, stripping the overburden at quarries, etc.

As Used by County Road Officials

County commissioners are using the Smith excavator, for instance, in gravel pits and on road work. Green County, Wisconsin, has used one in a gravel pit, loading gravel directly into their crusher. St. Louis County, Minnesota, has used one with marked success in gravel and

SMITH EXCAVATOR AND LOADER DIGGING IN SAND PIT.

crushed stone digging and loading and on cut-and-fill road work. Sheboygan County and Green Lake County, Wisconsin, have both used these machines successfully on road work and in pits.

It is a speedy, economical and efficient machine—easily operated and capable of standing lots of hard service.

Operating Details of the Machine

These operating details may prove of added interest: The scraper, or digging slip, is controlled by the two cable drums—the hoisting drum and the retrieve drum. The hoisting drum has two speeds, permitting a digging speed for the scraper of 106 ft. per minute. When the scraper is filled, it can be hauled to the machine at the rate of 206 ft. per minute. In that same speed it is elevated to the point where the load is dumped. Then the pivot arms descend with the scraper and the retrieve drum carries the scraper back to the man in the hole at the speed of 228 ft. per minute.

The machine is furnished complete with digging scraper, cables, sheaves and blocks, bridle chain and stakes, wagon pole and all the necessary accessories. An 18-h.p. two-cylinder motor is used in this machine, with water-cooling tank. The frame of the machine consists of heavy channel steel, hot-riveted and strongly gusseted. Top and sides of upper frame consist of sheet metal bolted to frame and forming a house over main machinery and power unit. All parts are easily accessible and protected against dirt and rain. Complete shipping weight of the machine with all fittings is 11,000 lbs.

The Smith excavator and loader is made by the T. L. Smith Company, Milwaukee, manufacturers of concrete mixers, pavers and construction equipment for over 20 years. The excavator has been on the market for about 8 years, and during that time it has gone through a series of changes, dictated by actual operating conditions, until it is now on a high plane of efficiency. The machine costs considerably less than a steam shovel, and, as one user said, "it fills the gap between the expensive steam shovel and the still more costly gang of hand shovelers."

RELAYING GRANITE BLOCK PAVEMENT ON ASPHALT MACADAM BASE AT PROVIDENCE, R. I.

When the Department of Public Works of Providence, R. I., had to relay a considerable yardage of old granite block pavement last year, the engineers decided to use an asphalt macadam base under the relaid blocks. It is interesting to note the procedure in this construction.

The old granite block pavement was laid originally partly on a 6-in. cement-concrete foundation and partly on a rolled broken stone base. Much of the pavement had settled in places after undergoing considerable traffic, and it was found necessary last year to relay the block.

The first step was to take up and clean the old blocks thoroughly, no recutting being necessary. The sub-base was of gravel, varying in thickness up to 8½ ins. This sub-base was rolled thoroughly, and on top of it was placed 2-in. trap rock, which was rolled to an average depth of

3 ins. Smaller sized trap rock was spread and rolled to fill the larger voids.

This stone was then given a penetration treatment of No. 96 Texaco Asphalt, using about 1½ to 1¾ gals. per square yard. Stone chips were then spread and the base was rolled. Following this a sand cushion 1 in. or more in depth was spread on the asphalt macadam base, and on this cushion the granite blocks were relaid.

After the blocks were laid, and a small amount of stone chips had been swept into the interstices, the joints were filled with Texaco Asphalt. Sufficient asphalt was spread so as slightly to flood the surface of the blocks for about one-third their area.

After the Texaco asphalt filler had been applied, the surface was covered with clean stone chips and rolled, after which the street was open to traffic.

The engineers in charge are thoroughly pleased with the results, and the street offers an excellent thoroughfare for heavy traffic with a minimum of noise.

"LE CLAIR" SCRAPER ADDED TO SAUERMAN BROS.' LINE

The "Le Clair" power drag scraper is now being manufactured and sold by Sauerman Bros., 1142 Monadnock Block, Chicago, under an agreement with Mr. S. D. Le Clair, of San Francisco, Calif., owner of the patent rights.

VIEW OF "LE CLAIR" POWER DRAG SCRAPER IN OPERATION.

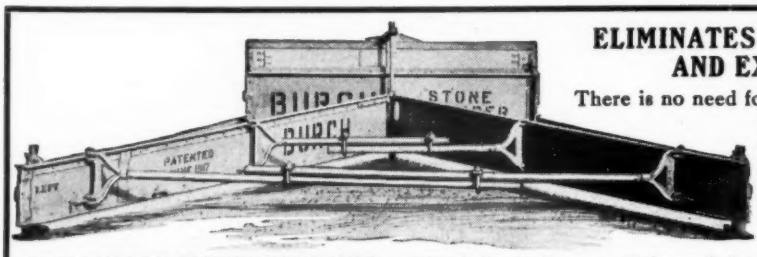
The "Le Clair" scraper, as will be noted from the accompanying illustration, is simple in construction and combines light weight with large capacity. In conjunction with the three types of Sauerman bottomless power scrapers, which are known as the "Crescent," "Excavator" and "Type C," the "Le Clair" gives Sauerman Bros. a complete line of scrapers for excavating and moving all classes of materials. Thus, Sauerman engineers, in planning power scraper installations for gravel pits, coal storage yards and so forth, now are in a position to employ any one of four differently designed scrapers, and can specify whichever is best suited to the conditions and requirements of the proposition then under consideration.

PERSONAL ITEMS

Mr. Edmund T. Perkins, M. A. S. C. E., First National Bank Building, Chicago, Illinois, sailed on March 15th for Barranquilla, Colombia, South America. Mr. Perkins goes to South America to report upon construction work in which American capital is interested.

Gunni Jeppesen, formerly Chief Engineer of the Strauss Bascule Bridge Company, has joined the Chicago Bascule Bridge Company as Associate Engineer. Mr. Jeppesen, who is a graduate of the State Polytechnical Institute at Copenhagen, Denmark, was connected with the Strauss Company for twelve years, from its inception until 1917, and since then has been engaged in industrial plant work as Structural Engineer of the Leonard Engineering Company.

Captain O. F. Healey, recently promoted to the office of Assistant City Engineer of Chicago, has been in the service of the city for five years with two years' service in the army. He was Captain of Engineers in charge of construction in the northwest quarter of France on the staff of the Director General of Transportation. Formerly he was Engineer of Contracts for the city. Under his regime there was installed a standardized and business-like system of contracts. Among the important engineering positions he has held was that of Assistant Chief Engineer of the Gravity Water Supply for Tacoma, Wash. He is a native of Aurora, Ill., and a graduate of the University of Chicago.



ELIMINATES HAND SPREADING AND EXTRA LABOR

There is no need for hiring ten or a dozen extra men for stone spreading when you use a Burch Spreader. It spreads as the stone is unloaded, requiring but one man—the truck driver.

THE BURCH STONE SPREADER meets all the requirements of the road through easily and quickly made adjustments. Distributes an even depth and uniform width of stone at all times. Saves enough in two miles to pay for itself. A wonderful material and labor saver. Write today for complete description.

THE BURCH PLOW WORKS COMPANY, Dept. G-5 Crestline, Ohio

WM. E. DEE CLAY MFG. CO.

Proprietors of MECCA CLAY WORKS

Manufacturers of

STANDARD AND DOUBLE STRENGTH

Sewer Pipe, Drain Tile, Culvert Pipe, Well Tubing, Flue Lining, Wall Coping and Fire Brick.

WORKS { Mecca, Parke County, Ind., on C. & E. I. R. R.
Newport, Vermillion County, Ind., on C. & E. I. R. R.

Chicago Office, 30 N. LaSalle Street.

THE CUMMER ROAD ASPHALT PLANT

THREE SIZES THREE UNITS

Capacity 750, 1250 and 1800 Square Yards 2-inch Top or Macadam Daily

THE CUMMER ONE-CAR ASPHALT PLANT

Capacity 2000 Square Yards 2-inch Top or Macadam Daily

THE F. D. CUMMER & SON COMPANY

CLEVELAND, OHIO New York Office, 19 West 44th Street

Faultless Service in Every Respect THAT'S WHAT YOU NEED WHEN TAKING MEASUREMENTS

That's what you can rest assured you are getting when you use

LUFKIN TAPES

PIONEERS IN CONNECTION WITH THE NOTEWORTHY IMPROVEMENTS MADE IN TAPES

More of them are in use than all other makes because they have for years consistently maintained the highest reputation

Send for Catalog No. 26 **THE LUFKIN RULE CO.** SAGINAW, MICH.
NEW YORK. LONDON, ENG. WINDSOR, ONT.

Holbrook, Warren and Andrew is the name of the corporation which has purchased the business of Miller, Holbrook, Warren and Company, Decatur, Ill. Under the latter name, the firm has built up a substantial professional business in the structural and municipal fields. Mr. Frank D. Holbrook was engaged for a period of about 15 years on Ohio River improvements for the U. S. Government. Mr. Willis D. P. Warren has been engaged in various classes of engineering work in Illinois for the past 17 years, devoting the greater portion of this time to municipal projects. Captain Clarence R. Andrew was formerly with the Government on Ohio River improvements and served in France in the Engineer Corps.

FOR SALE OR RENT

One 10-ton "Peerless" Steam Road Roller; first-class condition; used on six miles road work. Address

M. F. Normoyle & Sons,
Box 221 Roanoke, Va.

Contracts Awarded

ROADS AND STREETS.

Ala., Gadsden—Southern Paving & Constr. Co., Chattanooga, Tenn., awarded contract for street paving here at $171,708. A number of residence streets will be paved with asphaltic conc. One or two short streets in wholesale business dist. will be paved with vitr. brick.

Ariz., Tucson—L. Hoopes, Miami, awarded contract by St. Hwy. Comm. to construct 12½ miles paved road between Paso Robles and the Estrella River, San Luis Obispo Co., at $270,767.

Cal., Oakland—Bates & Borland, Oakland, awarded contract by St. Hwy. Comn. to construct 12½ miles paved road betw. Paso Robles and the Estrella River, San Luis Obispo Co., at $270,767.

Cal., Sacramento—Lynn S. Atkinson, C. C. Chapman Bldg., Los Angeles, awarded contract for paving with conc. 15.4 mi. State hwy., Kern Co., at $258,251.

Colo., Boulder—Strang & McGuire Co., Utah Savings & Tr. Bldg., Salt L. City, awarded contract for 53,000 sq. yds. paving in business dist.; asph. on conc. base; $202,589.

Colo., Rocky Ford—Strang & McGuire Co., Utah Savings & Tr. Bldg., Salt L. City, awarded contract for paving 23 blocks Main St., Warrenite-Bitulithic, at $161,854.

Colo., Denver—State Hwy. Dept. let contracts to Monaghan & Cunningham, 1711 Market St., Denver, for grading, draining and sand-clay surfacing 5.912 miles Brush-Akron Rd., F. A. P. 39, Morgan Co., at $24,929; 4.497 mi. Salida-Canon City Rd.; F. A. P. 113, Chaffee Co., at $51,891, 3.087 mi. Del Norte-Saguache Rd., gravel F. A. O. 100, Rio Grande Co., at $23,298, 3.1341 mi. Dolores-Cortez Rd., gravel, F. A. P. 126, Montezuma Co., at $29,580; J. V. Stryker, 1507 Blake St., Denver, contr. for grading, draining, etc., 5.36 mi. Peyton-Ramah Rd., F. A. P. 55, El Paso Co., at $45,247; Mison, Clark & Teyssier, 204 W. 15th St., Pueblo, for grading, draining and surfacing 4.091 mi. rd—Bayfield to Archuleta Co. line, gravel, F. A. P. 101, La Platta Co., $41,378; E. O'Neil, Meeker, grading & surfacing 1.8 mi. Rifle-Meeker Rd., F. A. P. 128, Rio Blanco Co., at $14,321; W. B. Cheek, 213 Plum St., Ft. Collins, paving 1.333 mi. Ft. Collins-Loveland Rd., conc., F. A. P. 85, Larimer Co., $33,235; F. C. Dreher, 525 Coper Bldg., Denver, paving 1.117 mi. Longmont-Denver Rd., conc. F. A. P. 88, Boulder Co., at $29,643; Denver-Brighton Rd., conc., F. A. P. 89, Adams Co., $86,795; G. A. Dalgren, So. Cimarron St., La Junta, paving 1.377 mi. La Junta Cwink Rd., conc., F. A. P. 96, Otero Co., at $44,054; J. H. Rice, Buffalo, Wyo., paving 1.273 mi. Denver-Arvada Rd., conc., F. A. P. 120, Jefferson Co., at $30,805; Levy Constr. Co., Symes Bldg., Denver, bldg. two-span conc. brdg. on La Jara-Alamosa Rd., F. A. P. 124, Conejos Co., $11,924; L. Robbins, Box 41, Boulder, bldg. 2 conc. brdgs. over Brush Gollow Crk., and Chandler Crk. on Florence Canon-City Rd., and Florence-Penrose Rd., Fremont Co., at $3,632 and $7,091, respectively.

Iowa, Des Moines—C. O. Mitchell, S. 15th St., Des Moines, awarded contract for grading Runnels Hwy., at 38½c, 117,600 cu. yds. earth.

Ky., Glasgow—R. B. Tyler & Co., 144 S. 4th St., Louisville, awarded contract for bldg. 11 miles rd.

KOLESCH SURVEYING INSTRUMENTS FOR SERVICE

Test a "KOLESCH" Instrument —at our expense

We will gladly send municipal engineers our instrument to test without any obligation to purchase until it has proved its worth. **Kolesch** Transits and Levels are sturdy, accurate and moderate in price. Every detail has been studied to give an instrument that can be counted on for unvarying reliability and long life.

Send for Catalog illustrating full line of engineers' and draftsmen's supplies

The Popular Kolesch "PIONEER" TRANSIT No. 7710

KOLESCH & COMPANY

138 Fulton Street New York City

from Glasgow north to Hart County Line, 16 ft. wide., Ky. rock asph. on old Telford base, at abt. $470,000.

Md., Baltimore—State Rds. Comm., 601 Guardian Bldg., Baltimore, let contracts for paving (1) 2½ mi. rd. from Denton to Prestons, Caroline Co.; (2) 1½ mi. lateral joining Salisbury and Ocean City Rds., Wicomico Co.; (3) 3 mi. link in Easton-Claiborne Rd., Talbot Co., (4) 3.62 mi. DuPont Blvd., Worcester Co., (5) 2¼ mi. rd. from Bethel Ch. to Black Horse, all concrete, to A. B. Sandridge & Co., Georgetown, Del., (1), $78,496; D. A. Hannaman Constr. Co., Salisbury; (2) $78,496, Piel Constr. Co., Edmondson Ave., Baltimore; (3), $96,954; (4), $133,-312, W. H. Hohn, Port Deposit, (5), $75,651.

Minn., St. Paul—Fielding & Shepley, Princeton St. and Mt. Curve Blvd., awarded contract for paving 5 miles St. rd. No. 4—city limits to Lake Ave., White Bear, except dist. betw. Kohler Rd. & Goose Lake Crossing, 20 ft. wide, F. A. P. 177, Warrenite Bitulithic, at $329,866.

Mo., Kansas City—Norton Bros., Kansas City, awarded contract for grading, regrading and constructing retaining walls on Twenty-third St., traffic Way link, at $345,070.

Magnolia, Miss.—Nealy Constr. Co., Jackson, Miss., awarded contract for 6.4 miles vitr. brick road betw. Magnolia and McComb City, at $238,863.

Mo., New Madrid—W. D. Lonergan, awarded contract for 19.81 miles, F. A. P. 40, width 24 ft., at $237,351. 186,658 sq. yds., one 6-ft. gravel surfaced pavement; also 4 bridges.

N. Y., Albany—State Hwy. Dept. let contracts for improving 4.69 mi. Belmont-Phillips Crk., Part. 1, Rd. 1559, Allegany Co., to H. W. Patterson, Hornell, at $147,878; 2.28 mi. Rhinebeck-Rhinecliff Rd., $1530 Dutchess Co., to Kennedy Constr. Co., Albany, at $78,301; 2.71 mi. Attica-Batavia Part 1, Rd. 8022, Genesee Co., to Oatka Engrg. & Constr. Inc., Warsaw, $91,189; 8.37 mi. Carthage-Antwerp, Part 3, Rd. 8023, Jefferson Co., to Smith Bros. Constr. Co., Lyons Falls, $259,522; 5.99 mi. New Woodstock-Cazanovia Rd. 8024, Madison Co., to G. W. Chambers, Rochester, $184,340; 2.99 mi. Sheridan Blvd.-Burnside Ave.—Rockaway Turnpike, Rd. 1396, Nassau Co., to Clemento Constr. Co., Inc., New York City, at $17,993; 2.85 mi. Defreesville-West Sand Lake Rd. 5658, Rensselaer Co. to Malloy Constr. Co., Schenectady, at $113,448; 3.46 mi. Pattersonville-Scotch Ch. Rd., 1482, Schenectady Co., to W. L. Lawton, Glens Falls, at $124,651; 725 mi. Candor-Danby Rd. 8026, Tioga Co., to N. E. Young, Union, at $234,042; 5.68 mi. Salamanca-Elliottville, Part 2, Rd. 1509, Cattaraugus Co., and 5.41 mi. Rd. 1039, Rep. Con. 1286, Onondaga Co., to Greenfield Constr. Co., 89 Main St., Hornell, at $218,858 and $55,553, respectively; 3.94 mi. Fayetteville-Chittenango, Part 1, Rd. 8025, Onondago Co., and 9.37 mi. Williamtown-Redfield Rd. 8029, Oswego Co., to J. Johnson Constr. Co., 765 Abbott Rd., Buffalo, $138,861 and $263,600, respectively; 0.59 mi. Suffern Village; Lafayette Ave. Part 1, Rd. 1535, Rockland Co., and Suffern Village; Lafayette Ave. Part 2, Rd. 5649, Rockland Co. to Fleming, O'Brien & McEntegart, Inc., 401 W. 59th St., New York City, at $23,907 and $32,674, respectively.

N. C., Hickory—Atlantic Bitulithic Co., Richmond, awarded contract to lay 40,000 sq. yds. street paving and sidewalk, at $2.91 per sq. yd., or total of $161,000.

Ohio, Columbus—Mannix Bros., Findlay, awarded contract for grading, bldg. bridges and culverts and paving 3.202 miles Sec. B, Greenville-Covington Rd., brick, at $177,112.

Okla., Muskogee—Healy Constr. Co., Muskogee, awarded contract for 23 miles gravel road, Muskogee Co., at $262,171.

Okla., Tulsa—Contracts totaling $834,375.46 let for paving ten streets as follows: Tibbetts & Pleasant, Louis Ave., at $78,396; Columbia Ave., $27,410; 7th St., $181,303; 6th St., $80,215; 5th St., $97,708—total $465,033; Comstock & Smedley, 8th St., $125, 760; 9th St., $132,346; Evanston St., $21,-422; College Ave., $30,047; 5th Pl., $59,765; total, $369,341. Paving is to be 7-in. conc. without special surfacing.

Ore., Portland—Independent Asphalt. Paving Co., Seaboard Bldg., awarded contract by St. Hwy. Dept. of Oregon to pave approx. 10 miles hwy, at $321,056.

Ore., Salem—State Hwy. Comm. let contract for paving 10.55 mi. Hood River. Mosier Sec., Columbia River Sec., 16 ft. wide, Hood River and Wasco Cos., to A. O. Kern, Portland, at $350,915; 6.72 mi. Forest Grove, Gaston Sec., Tualatin Valley hwy., 16 ft. wide, Washington Co., also grading 5.12 miles Barclay Springs, Tammis Mill Sec. and the Dallos-California Hwy., Klamath Co., to Warren Constr. Co., Journal Bldg., Portland, at $224,754 and $69,122, respectively; 8.57 miles Salem So. Section, Pacific Hwy., Marion Co., to J. E. Bonnell, 760 Commerce St., Tacoma, at $280,139.

Pa., Harrisburg—St. Hwy. Commr. Lewis B. Sadler, awarded contrs. for road impvts. in 8 counties as follows: John Herman, Latrobe, Pa., to build 6895 ft. one-course rein. conc. rdway., Route 68, New Alexandria and Salem twp., Westmoreland Co., at $89,577; Chester General Contracting Co., East Liverpool, Ohio, for constr. of 26,953 ft. conc., Route 204, Darlington Boro. and Darlington Twp., Beaver Co., at $547,676; Heyman and Goodman, Jersey City, N. J., to build 36,706 ft. conc. rdway., Route 151, Doylestown Boro. and Warrington and Doylestown Twps., Bucks Co., at $417,713; Torquato Brothers' Co., Windber, Pa., to build 16,819 ft. conc. rdway, Route 222, Scalp Level Boro. & Richland Twp., Cambria Co., at $205,361; Souder Constr. Co., Lancaster, Pa., for constr. of 11,459 ft. rdway, Routes 41, 42, 44, 123 and 298, Gettysburg Boro. and Cumberland Twp., Adams Co., at $174,090; Chas. H. Fry Constr. Co., Erie, Pa., for constr. of 9,924 ft. conc. rdway. on Route 86, E. Springfield Boro., Erie Co., at $108,715; T. L. Evans & Sons, Danville, Pa., for constr. of 19,487 ft. rdway. on Route 3, Cooper & Montour Twps., Montour and Columbia Cos., at $228,036. On first 3 projects mentioned and on fifth project, borough pays cost of extra width of paving.

S. C., Newberry—Southern Paving & Constr. Co., east 11th St., Chattanooga, Tenn., awarded contract for paving various streets, at abt. $180,000.

Tenn., Jackson—E. D. Harvey & Co., Memphis, Tenn., awarded contract by St. Hwy. Dept. for 56¾ miles State Hwy., Madison Co., at $198,780.

Tenn., Memphis—Oliver Constr. Co., Little Rock, awarded contract for conc. surfacing rd. from Memphis to Marion, 8½ miles, at $255,200.

Tenn., Sparta—A. F. Beardon, Birmingham, awarded contract for 13½ miles St. Hwy. No. 1, White Co., at $354,240.

Tex., Fort Worth—Texas Bitulithic Co., Dallas, award. contr. for 140,000 sq. yds. street paving at $494,200.

Tex., Marlin—Cook & Arrington, Crockett, Tex., and Harris & Powell, Tyler, Tex., awarded contract for 46 miles of roads at $308,000. 43,633 cu. yds. gravel surfacing.

Tex., Marshall—Harrison Co. let contract to Smith Bros., Crockett, and Healy Constr. Co., Dallas, for 24.9 miles hwy. No. 8, 12 ft. wide, gravel base, at $263,436.

Tex., Rusk—Smith Bros., Crockett, Tex., awarded contract for impvt. of 40 miles of roads, Cherokee Co., at $200,000.

Va., Martinsville—G. T. Franklin, Bassetts, Va., awarded contr. for 10 miles sand clay rd., $250,000 available.

Va., Wytheville—Wise County let $350,000 contracts for road construction as follows: G. W. Scott—road from Appalachia to Linden; Wise Constr. Co.—road from Big Stone Gap to East Stone Gap, etc.; Collier & Bruce—road from St. Paul to Russell Co. line; Berks Constr. Co.—road from Norton to Wise. All waterbound macadam, with exception of Norton-Wise road, which will be bitum. macadam.

Wash., Olympia—Following contracts let for state highway work: Olympia Hwy., Thurston County line to Kamilche, Mason County, to Wood Bros. & Tomei, Pt. Angeles, at $114,522; National Pk. Hwy., Muck Crk. to Ohop, Pierce Co., to J. W. Hover & Co., Everett, at $153,097; Pacific Hwy. at brdg. over Nisqually River, Pierce and Thurston Cos., Nisqually embankment, to Anderson & Lilljeback, Tacoma, at $28,939; Pacific Hwy., Blanchard to Allen, Skagit Co., to Skagit Constr. Co., Mt. Vernon, at $192.383; Pacific Hwy., Pioneer to La Center, Clark Co., to T. M. Morgan, Everett, at $196,471.

W. Va., Martinsburg—P. Flanigan & Sons, Baltimore, awarded contr. for street paving at $184,040.

Wis., Green Bay—Following contracts let for road work: Green Bay-West De Pere, Green Bay-Manitowoc, Green Bay-Shawano roads, to Rudolph Hansen Co., Green Bay, at $279,896; Bay Shore-Benderville Rd. to Ed. Shuster, Denmark, at $19,-680; Humboldt Rd., to Brogan & Burns, Green Bay,

at $29,150; Belgian Rd. to Neihaus & Stahl, Greenleaf, at $41,999; De Pere-Greenleaf Rd. to Jorgenson Constr. Co., Denmark, at $23,254; Green Bay-Shawano Rd., low bidder, L. A. Larson, Oshkosh, $120,099.

SEWERAGE AND SEWAGE TREATMENT.

Ariz., Holbrook—Ormon Constr. Co. awarded contract for constructing sewer and water systems for Holbrook, at $108,078.

Ariz., Phoenix—Claude Fisher, Phoenix, awarded contr. for constr. of vitr. pipe sewer extensions for city, at $72,612. Contr. involves 55,000 ft. 8-in. and 9,500 ft. 10-in. pipe; 1340 8-in. wyes and 56 10-in. wyes; 147 manholes and 53 flush tanks.

Cal., Los Angeles—S. Zarubica & P. S. Tomich, 3006 6th Ave., awarded contract for constructing cem. pipe sewer in Orange Grove Ave., sewer dist. at $27,687.

Cal., Patterson—W. J. Schmidt, Berkely, awarded contract to construct sewer system for Patterson, at $52,499.

Conn., Stamford—F. Palmer & Co., 131 Sound View Ave., awarded contr. for constr. of trunk sewerage line near municipal dock, at $29,250.

Ill., Kankakee—H. McMullen & Son, Kankakee, awarded contract for constructing san. improvements (sewers) in various streets, at abt. $25,000.

Ind., Lebanon—Bowyer & Son, New Castle, awarded contract for san. sewerage disp. plant at $37,000.

Ind., Richmond—Sheets & Canfield, Columbus, Ohio, awarded contr. for constructing relief sewer in S. 7th St. (conc. pipe constr.), at $42,827.

Iowa, Ute—W. B. Cartor, U. S. Bldg., Sioux City, awarded contract for san. sewer and disp. plant, 4 miles vitr. pipe, 8 to 12 in. Work has been started. $55,000.

Mich., Detroit—Gillespie Conts. Co., low bidders for constr. of Sec. 1, Conner's Crk. sewer, at $2,190,950.

Mich., Pontiac—Gallager-Burke Constr. Co., 1228 Bonnie Ave., Lakewood, Ohio, awarded contract for bldg. san. trunk sewer in Bagley St., from Voorhies St. to Navajo Rd., at $177,644; northeast storm sewer, to Coffrey & Bahlin, Pontiac, at $89,006.

N. Y., New York City—Henry E. Fox Co., 81 East 125th St., awarded contract for completion of sewer in 42nd street, $18,510.

N. Y., New York—A. Ferris, 672 DeGraw St., Brooklyn, awarded contr. by Commr. Public Welfare, City, for erecting and completing sewer and drain. system for 21 pavilions at Sea View Hospital, West New Brighton, at $50,002; M. Del Balso, 1434 Bryant Ave., awarded contract by H. H. Curran, Pres. Manhattan Boro., for bldg. sewer in Magaw Pl., W. 181st to W. 183 Sts., at $31,124.

N. Y., Utica—N. D. Peters & Co., 216 Kossuth Ave., awarded contract for bldg. East Utica san. sewer, at about $65,000.

Ohio, Cleveland—Chas. S. Haddad, award. contr. for constr. of sewer in E. 128th St.; Penobscott Ave., N. E., to Woodside Ave., at $14,813; Water and Sewer Impvt. Co., for constr. of sewer in W. 51st St., at $2,625; Randall & Cooper, for constr. sewer in Oak Park Ave., S. W., at $19,250; A. J. Gavin, for constructing sewer in Arcade Ave., at $10,488.

Ohio, Cleveland—City let contracts for bldg. sewers in Arcade Ave., E. 156th to E. 167th Sts., to A. J. Galvin, Lennox Bldg., at $10,488; Oakpark Ave., W. 35th St. to Broadview R., to Randall Cooper, Lorain, at $19,250.

Ohio, Cuyahoga Falls—L. I. Stark, 30 W. Tallmadge Ave., Akron, awarded contr. for bldg. sewers in 2d, 3d, and 4th Sts., at $56,638.

Ohio, Lima—McHugh & Cole, local, awarded contracts for three sewers at total cost of $16,672.95.

Ohio, Warren—Mates & Erway, Warren, award. contract for bldg. sewers in Sewer Dist. 1, at abt. $550,000.

Ohio, Cleveland—A. De Zulo, Bedford, awarded contr. for bldg. 4660 ft. vitr. sewer in E. 105th St., Adams to St. Clair Aves., at $148,643.

Ore., Portland—J. F. Shea, awarded contract for constr. of Balch Creek Sewer, at $168,809.

Pa., Philadelphia—City let contracts for bldg. 1082 ft. sewer in 10th St., and Chelten Aves., 6½ ft. brk. sewer, reduced cradle, stone blk. invert, 6½ ft. brk. sewer in hard rock, stone blk. invert, 5½ ft. brk. sewer in hard rock, to Est. D. McMahon, Chelten Ave., at $61,565; Charles St., 5½ rock, 5½ ft. in reduced cardle, vitr. brk. invert, 5 ft. in stone invert in hard rock, 5 ft. in stone invert, to McMemamin Co., Philadelphia, at $39 per ft. hard rock, $45 per ft. red. cradle; Packer St. to Cunningham & Murray, Philadelphia, at $53,513; reconstr. of main sewer in York St., 1061 ft., 6x7 ft. rein. conc. pipe and 231 ft. 7 ft. pipe, brk. red. cradle, stone invert, and 1022 ft. Bigler St., 6x7 ft. rein. conc. sewer on yellow pine piles, to J. J. McHugh, 1430 S. Penn. Sq.

Pa., Pittsburgh—T. Gronin Co., South 18th St., awarded contract for bldg. Soho Run Trunk Sewer, at $172,830.

Pa., Beaver Falls—Jno. F. Tayler, Beaver, award. contract for constr. of Beaver Falls outfall sewer from disposal plant to a dist. below Fallston dam, at $20,321.

Tex., Comanche—E. L. Dalton, Schulter Bldg., Dallas, Tex., awarded contract to construct 3 miles sewer lines and erect $6,000 addn. to disposal plant; capy. entire plant abt. 500 connects. Total cost $20,000.

Pa., Williamsport—Walter R. Cliffe Co., Philadelphia, Pa., awarded contract for constr. of storm sewers in Hepburn, Front, Franklin, Oliver, Walnut Sts., etc., at $33,990.

Pa., Williamsport—City let contract for bldg. storm water sewer in W. 3rd, Park and Rose Sts., to Busch and Stewart, Trust Bldg., at $25,750; Campbell and 3rd Sts., along trks. Penn. R. R., to Seaside Contg. Co., Williamsport, at $6,800; Park St. to W. R. Cliffe Co., Williamsport, at $5,000.

R. I., Woonsocket—Eastern Constr. Co., 660 Winter St., awarded contract for bldg. surface water sewer draing. system, So. Main and Bollow Sts., at about $25,000.

WATER SUPPLY AND PURIFICATION.

Ariz., Holbrook—Ormon Constr. Co. awarded contract for constructing water and sewer systems for Holbrook, at $108,098.

Conn., Torrington—J. De Michael & Bro., 58 High St., awarded contr. by Torrington Water Company for constr. of 1 mile 16 in. cast iron pipe from dam at Hart Brook to Drakeville, at about $55,000.

Idaho, Blackfoot—Wheelright Co., Ogden, Utah, awarded contract for constr. of water works at $188,300. Cast iron mains are to be used, comprising 6, 8, 10, 12 and 16-in. pipe; Matheson joint steel pipe will be used for rest of system.

Ill., Rockford—R. P. Beckstrom & Co., Indiana ave., awarded contr. for constr. of brick and rein. conc. well, air-lift and full pumping equipt., 500,000-gal. reservoir, 2,250 cu. ft. air compressor, 15,000,000-gal. light duty steam driven pumping sta. and boiler room, at abt. $90,000.

Kans., Topeka—City let general contr. for bldg. filtr. plant and improving water works systems to Unit Constr. Co., Title Guarantee bldg., St. Louis, Mo., at $221,398; filter equipt. to Robert Filter Mfg. Co., 6th and Columbia Sts., Darby, Pa., $23,370; cast iron pipe to U. S. Cast Iron Co., 122 S. Michigan Ave., Chicago, at $22,749; tanks and towers, to Pittsburgh-Des Moines Steel Co., Des Moines, Ia., at $5,950; centrif. pumps to Midwest Eng. Co., 615 Reliance Bldg., Kans. City, Mo., at $2,765.

Md., Baltimore—Whiting-Turner Constr. Co., Stewart Bldg., awarded contract to raise Loch Daven Dam. on Gunpowder River, from 180 to 240 ft., at $478,166.

Mich., Detroit—Flower Valve Mfg. Co., awarded contract for furnishing Bd. Water Commrs. 20 hydraulically operated mud valves at $3,704; furnishing 6 sluice gates at $25,113; Thompson-Starrett Co., awarded contr. for conc. superstruct. of filter plant at $815,375.

Mich., Detroit—Wolverine Engrg. & Constr. Co., Detroit, awarded contract for superstruct. for high pressure pumping station at ft. of Randolph St., at $61,552.

Mich., Detroit—Bd. Water Commrs. will extend by day labor water mains involving 100 tons 13½-in. O. D. steel pipe and 50 tons 18-in. lap welded steel pipe. Gillespie Contg. Co., 50 Church St., New York City, let contract by Water Bd. for labor, material, etc., for laying 3,200 ft. 48-in. steel water pipe, together with specials, except gate valves, at $158,162.

Mo., Moberly—Lynch & McDonald, Moberly, awarded contract for bldg. 1 sty. pumping station, 1 sty. filter plant and 1 sty. chem. storage house, all brick, and 200 cu. yds. conc. for machinery foundations, at $224,005.

BUYERS' GUIDE

Aerial Tramways.
American Steel & Wire Co.

Armor Plates.
Truscon Steel Co.

Asphalt.
Barber Asphalt Co.
Bitoslag Paving Co.
The Barrett Co.
New Orleans Refining Co.
Pioneer Asphalt Co.
Sinclair Refining Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Asphalt Paving Co., The

Asphalt Filler.
Barber Asphalt Paving Co.
The Barrett Co.
Bitoslag Paving Co.
Sinclair Refining Co.
Standard Oil Co. (Indiana)
The Texas Co.
Warren Bros. Co.

Asphalt Floors.
Barber Asphalt Paving Co.
The Barrett Co.
Sinclair Refining Co.
The Texas Co.
Warren Bros. Co.

Asphalt Machinery.
Barber Asphalt Paving Co.
Cummer & Son Co., The F. D.

Asphalt Plants.
Austin Machinery Corporation.
Barber Asphalt Paving Co.
Cummer & Son Co., The F. D.
Warren Bros. Co.

Asphalt Railroad Plants.
Barber Asphalt Paving Co.
Cummer & Son Co., The F. D.
Warren Bros. Co.

Asphalt Surface Heaters.
Barber Asphalt Paving Co.

Asphalt Tools.
Barber Asphalt Paving Co.
Warren Bros. Co.

Asphalt Tool Wagons.
Barber Asphalt Paving Co.

Auto Fire Apparatus.
Diamond T Motor Car Co.
Duplex Truck Co.
Garford Co., The
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Back Fillers.
Austin Machinery Corporation.
Pawling and Harnischfeger.

Barber Brand Cold Repair Cement.
Barber Asphalt Paving Co.

Bar Cutters and Benders.
Koehring Machine Co.

Bars, Reinforcing.
Truscon Steel Co.

Bermudez Road Asphalt.
Barber Asphalt Paving Co.

Binders, Road.
Barber Asphalt Paving Co.
The Texas Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Bitulithic Pavements.
Warren Bros. Co.

Bodies.
Lee Loader and Body Co.

Braces, Extension.
Kalamazoo Fdy. & Machine Co.

Brick Rattlers.
Olsen & Co., Tinius.

Brick-Testing Machinery.
Tinius Olsen Testing Mach. Co.

Bridges.
Lewis-Hall Iron Works.
Pan-American Bridge & Construction Co.

Buckets, Dredging, Excavating and Sewer.
Pawling and Harnischfeger.

Buckets, Dumping.
Pawling and Harnischfeger.

Cableway Accessories.
Sauerman Bros.

Cableway Excavators.
Sauerman Bros.

Calculators.
Kolesch & Co.

Car Pullers, Electric.
Mead-Morrison Mfg. Co.

Car Unloaders.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.

Castings.
American Cast Iron Pipe Co.
U. S. Cast Iron Pipe & Fdy. Co.

Cast Iron Pipe.
American Cast Iron Pipe Co.
U. S. Cast Iron Pipe & Fdy. Co.

Catchbasins.
Dee Co., Wm. E.
Madison Foundry Co.

Cement, Portland.
Portland Cement Association.

Cement Testing.
Kirschbraun, Lester.

Cement Testing Machinery.
Tinius Olsen Testing Mach. Co.

Chimneys, Concrete.
Truscon Steel Co.

Chimneys, Steel.
Lewis-Hall Iron Works.

Chloride of Lime.
Pennsylvania Salt Mfg. Co.

Chutes, Concrete.
Heltzel Steel Form & Iron Co.

Concrete Mixers.
Austin Machinery Corporation.
Koehring Machine Co.
Lakewood Engineering Co.
Smith Co., T. L. The

Concrete, Reinforcement.
American Steel & Wire Co.
Truscon Steel Co.

Conduits.
Cannelton Sewer Pipe Co.
Truscon Steel Co.

Conduit Rods.
Stewart, W. H.

Conduits, Wood, Creosoted.
Republic Creosoting Co.

Consulting Engineers.
Alvord, John W.
Artingstall, Wm.
Brossmann, Chas.
Burd & Giffels.
City Wastes Disposal Co.
Dow & Smith.
Fargo Engineering Co.
Flood, Walter H., & Co.
Samuel A. Greeley.
Hill & Ferguson
Howard, J. W.
Hunt & Co., Robert W.
Jones, Sam L.
Kirchoffer, W. G.
Kirschbraun, Lester.
Potter, Alexander.
Shields, W. S.
Van Trump, Isaac.
Wells, James P.

Contractors.
City Wastes Disposal Co.
Sullivan, Long & Hagerty.
Warren Bros. Co.

Contractors' Tools and Machinery.
Austin Machinery Corporation.
Austin-Western Co., Ltd., The
Barber Asphalt Paving Co.
Good Roads Machinery Co., Inc.
Koehring Machine Co.
Lakewood Engineering Co.
Littleford Bros.
Smith Co., T. L. The

Contractors' Wagons.
Austin Machinery Corporation.
Austin-Western Co., Ltd., The

Conveying Machinery.
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.
Portable Machinery Co., Inc.
Webster Mfg. Co.

Cranes and Hoists.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.
Pawling and Harnischfeger.

Creosote.
The Barrett Co.
Republic Creosoting Co.

Creosoted Wood Block.
(Factory Floors, Bridge Floors)
Republic Creosoting Co.

Crushers, Rock and Ore.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Crushed Stone.
Cleveland Stone Co., The

Culvert Molds.
Austin-Western Co., Ltd., The
Storms Mfg. Co.

Culvert Pipe, Cast Iron.
American Cast Iron Pipe Co.
Cast Iron Pipe Publicity Bureau

Culvert Pipe, Vitrified.
Cannelton Pipe Co.
Dee Clay Mfg. Co., Wm. E.

Culverts.
Newport Culvert Co.
Truscon Steel Co.

Curb and Gutter Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Curb Bar.
Truscon Steel Co.

Curbing, Sandstone.
Cleveland Stone Co., The

Direct Oxidation Process.
Direct Oxidation Process Corp.

Drag-Line Excavators.
Austin Machinery Corporation.

Drag Scrapers.
Austin-Western Road Machinery Co.

Drain Tile.
Dee Clay Mfg. Co., W. E.

Dryers.
Cummer & Son Co., The F. D.

Dump Cars.
Austin-Western Road Machinery Co.

Dump Wagons.
Austin-Western Road Machinery Co.

Mont., Helena—C. E. Green, Salt Lake City, Utah, awarded contract for laying pipe line from Rimini to Ten-Mile Reservoir, involving 40,535 lin. ft. 12-18 in. pipe, 37 manholes and covers, etc., at $103,319.

Mont., Lewiston—City let contract for laying 14,100 lin. ft. 14-in. cast iron water main and 12 in. water mains in 2nd and Watson Sts., to Two Miracle Conc. Co., Lewiston, at $11,030; furnishing 12 in. pipe to United States Cast Iron Pipe Co., at $24,938; 14 in. to American Cast Iron & Pipe Co., at $3,860; valves, to Montana Hdw. & Lbr. Co., 220 W. Main St., at $1,928; lead and jute, to Wensley Metal Products Co., at $2,505.

N. Y., New York—Frank L. Paino, 401 Woodland Ave., Wood Haven, N. Y., awarded contract for furnishing, delivering and laying water mains and appurts. in Blake Ave., Junius St. and in Colonial Road, Boro., of Brooklyn, at $70,776.

N. Y., St. George, S. I.—S. De Stephano, Glen Ave., awarded contract for furnishing, delivering and laying water mains in Ocean, Richmond, Vanderbilt, Wadsworth and Western Aves., Edgewater Sts., etc., here, at $88,376.

N. Y., Yonkers—Philipsburgh Constr. Co., 15 N. Bway., awarded contract for bldg. filter bed covers, at about $150,000.

Ohio, Cincinnati—Joseph E. Lowes Co., city, has contract to construct the $89,000 reservoir near Calvary Cemetery, designed to give adequate distribution of water to different sections of city.

Okla., Mountain View—C. H. Everett, Hutchinson, Kans., awarded contract for bldg. pumping station and power plant at abt. $30,000.

Pa., Philadelphia—U. S. Cast Iron Pipe and Foundry Co., Burlington, N. J., awarded contract for furnishing cast iron pipe for pumping stations at Belmont and Queen Lane, at $280,000.

Utah, Brigham City—Gray & Murdock, Salt Lake City, awarded contr. to intake dam, 10,915 ft. 30 in. redwood pipe continuous stave, 1,362 ft. 30 in. welded steel pipe, 1,052 ft. 28 in. welded steel pipe, power house, 24x24, brdg. retaining walls, etc., etc., at $73,738; Pelton Waterwheel Co., San Francisco, contr. for furnishing two 750 h. p. wheels, governor and exciter impulse type of wheels, etc., at $24,505; Westinghouse Elec. Co., Pittsburgh, contr. for furnishing two 600 KVA generators, 1 motor generator set for excitation of both wheels, also 1 water wheel exciter of capy. to excite both generators at $15,659. Installation of hydraulic and elec. machy. also awarded this company, at $2,498.

Wash, Tacoma—Joseph Warter, local, awarded contract for laying iron water mains in Park Ave., S. 66th to 84th Sts., at $38,245.

Wyo., Evanston—Wheelwright Constr. Co., Ogden, Utah, awarded contr. for bldg. underground water collecting systems; 9 miles redwood staye pipe (16-in.), 1,000,000-gal. conc. reservoir, extending street distribution, etc., at about $230,000.

Prospective Work

ROADS AND STREETS

Cal., Azusa—$80,000 street impvt. bonds sold. Council considering method of expending funds. One plan is to employ competent road builder to take charge of work. In this event city will purch. rock crusher, grading roller, wagons, etc. Decomposed granite from canyon, 2 miles distant, may be utilized for the paving.

Cal., San Francisco—Appropriation of $790,808 for needed city impvts requested by City Engr. M. M. O'Shaughnessy in communication to Bd. Pub. Wks. Appropriation of $5,000 asked for grading Rincon Hill as part of contemplated impvt. of industrial section south of Howard and Mission Sts. Expenditure of this sum expected to put land in such shape that bids for actual constr. on $3,500,000 proposals can be asked. Other items include paving city property, $50,000; Collingswood St.; $45,000; Liberty St., $48,000, and Douglas St., $18,500.

Cal., Sacramento—Impvt. of 2d. St., Southern Pacific Sta. to K St., decided upon by City Comn. and Commr. of Sts. D. W. Carmichael. Comn. also voted to pave 42nd St., 2d to 11th Aves.

Cal., Stockton—Plans and specfs. ready for adoption to provide for several stretches of improved hwy. in different sections of county, and several brdg. designs have been prepared. 4 miles of rd. in Elliott Dist. are to be paved and plans & specfs. are completed. Co. Engr. will soon submit plans for graveling Carrall Hollow Rd. near Tracy. Will also recommend, at next session of Bd. of Supvrs., the grading and re-locating of hwy. along south side of Calaveras River, Bellota to county line.

Fla., St. Petersburg—City plans to pave and widen 2 miles First Ave., N. 2nd Ave., S., 6th and 4th Sts., 20 ft. wide, involving 15,000 sq. yds. vitr. brick. Abt. $250,000. F. N. Nelson, Direct. Bd. Pub. Wks.

Ill., Lincoln—City Commrs. passed resolution to pave 5th St., Logan to Washington; also Washington, 5th to the I. C. R. R., at jct., of Stringer Ave. and First St. It is figured that brk. paving will cost abt. $3.75 sq. yd. Specfs. for Wash. St. pavement call for vitr. brk. pavement 23 ft. wide; base 5 ins. conc. topped with 1 in. sand and vitr. brk. surf. conc. curb and gutter and conc. heading at intersects. unpaved streets. Est. cost of pavement, $15,644. Fifth, Washington to State, will be paved boulevard style, with parkway 20 ft. wide in center and rdway 15 ft. wide on both sides giving total rdway of 50 ft. State to Logan pavement will be solid with 30-ft. rdway. Total cost of this pavement would be $77,527.

Ill., Springfield—Bd. Local Impvts. decided to repave S. 6th St., also widen same, from Capitol Ave. to S. Grand Ave. It will be widened from Capitol to Edwards St. 18 ft. Pavement will be of brick with asph. filler and conc. fdn. Work expected to start within 80 days.

Iowa, Denison—Council passed resolution providing for 15 blks. additional paving; 24 ft. wide betw. curb lines.

Iowa, Des Moines—Army post rd. will be paved in near future. It is estimated that cost will be approx. $125,000.

Iowa, Sioux City—Six paving projects and two san. sewers authorized by city council. Bids will be advertised for the work. Three miles new paving called for in resolution prepared by Street Dept., which will be presented to City Council at regular meeting.

Iowa, New Hampton—Chickasaw Co. having plans prepared for grading, tiling and graveling 16 miles various roads. Abt. $90,000. D. D. McDonald. Aud. W. R. Garland, New Hampton, Engr.

Ill., Robinson—Bd. Local Impvts. opens bids abount June for improving 5,500 ft. Howard, Chestnut, Locts and Franklin Sts. Work involves 18,000 sq. yds. rein. conc. paving, conc. curbing and storm sewers. Abt. $85,000. E. F. Mail, Robinson, Engr.

Mass, Fall River—City plans to pave various streets, probably asphalt. Abt. $100,000.

Mass., Newburyport—City plans to pave High St. Abt. $100,000. W. McKay, Supt. of Hwys.

Minn., Minneapolis—Council voted to sell $410,000 Elwell grading bonds for work in following wards: First, $14,000; 7th, $16,000; 9th, $100,000; 10th, $80,000; 12th, $100,000; 13th, $100,000. Council also voted to issue bonds for paving University Ave., Bway to Lowry Aves; 25th St., Pillsbury to Pleasant Aves; Park Ave., Franklin Ave. to 28th St.; E. 24th St., Blaisdell to Pleasant Ave.; First Ave., S., 24th to 26th Sts., and Nicollet Ave., 42nd to 44th. F. W. Cappelen, City Engr.

Mont., Helena—St. Hwy. Comn., Helena, plans to gravel surface 36 mi. Miles City-Broadus Rd., $258,395; 22.8 mi. Miles City-Jordan Rd., $160,000; 9 mi. Miles City-Terry Rd., $50,000, all in Custer County.

N. J., Bridgeton—Bd. Freeholders, Cumberland Co., plan to pave 7½ mi. road from here to Shirley, 20 ft. wide, concrete. Abt. $459,000. W. M. Sharp, Bridgeton, Engr.

N. J., Dover—$16,000,000 will be received by State from Government for road and bridge contsr. and maint. this year. Part of this may be used in Morris Co. for road repair work.

N. J., Merchantville—Boro. having plans prepared for paving and resurfacing macadam streets in Wellwood Sec., with bitumen. Abt. $40,000. Remington & Vosbury, 6th & Market Sts., Camden, Engrs. Boro. also plans to construct conc. curbs and gutters and pave various streets with macadam. Abt. $65,000.

N. J., Mt. Holly—Northampton Twp. consider-

BUYERS' GUIDE

Dust Laying Compound.
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

Edge Protector.
Truscon Steel Co.

Electrical Wires & Cables.
American Steel & Wire Co.

Elevating Graders.
Austin-Western Road Machinery Co.

Elevators.
C. H. & E. Mfg. Co.

Engineering Instruments.
Kolesch & Co.
Lufkin Rule Co., The

Engines.
C. H. & E Mfg. Co.
Midwest Engine Co.

Excavating Machinery.
F. C. Austin Machinery Co.
Pawling and Harnischfeger.
Sauerman Bros.
Smith Co., T. L. The

Expansion Joint Compound.
The Barrett Co.
Pioneer Asphalt Co.
Truscon Steel Co.

Explosives.
E. I. du Pont de Nemours & Co.

Fence, Iron.
Cincinnati Iron Fence Co.

Fillers (Paving Joint).
Barber Asphalt Paving Co.
The Barrett Co.
Pioneer Asphalt Co.
Sinclair Refining Co.
The Texas Co.

Fire Brick.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Flue Liners.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Forms, Sidewalks, Curb & Gutter.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms, Road.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms (Sewers & Conduits).
Heltzel Steel Form & Iron Co.

Forms (Wall Bldg., Construction, Etc.).
Heltzel Steel Form & Iron Co.

Gas Pipe.
American Cast Iron Pipe Co.
U. S. Cast Iron Pipe & Fdy. Co.

Graders.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Granite Block.
Granite Paving Block Mfrs. Assn. of the U. S., Inc.

Gravel Screener and Loader.
Good Roads Machinery Co., Inc.
Jordan & Steele Mfg. Co., Inc.

Heaters (Rock and Sand).
Littleford Bros.

Heating Wagons (Oil and Tar).
Good Roads Machinery Co., Inc.
Littleford Bros.

Hoists (Concrete, Gasoline and Hand).
Pawling and Harnischfeger.

Hoists, Electric.
Mead-Morrison Mfg. Co.
Pawling and Harnischfeger.

Hoists, Steam.
C. H. & E. Mfg. Co.
Lewis-Hall Iron Works.
Mead-Morrison Mfg. Co.

Hot Mixers.
F. C. Austin Machinery Co.
Barber Asphalt Paving Co.

Hydrants.
Flower Valve Mfg. Co.

Inlets (Sewer).
Dee Co., Wm. E.
Madison Foundry Co.

Insulating Material.
The Barrett Co.
Pioneer Asphalt Co.

Joint Fillers (Paving).
The Barrett Co.

Kettles (Portable).
Barber Asphalt Paving Co.
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.

Loaders.
Brown Portable Conveying Machine Co.

Manhole Covers.
Madison Foundry Co.
Dee Co., Wm. E.

Mastic.
Pioneer Asphalt Co.

Meter Boxes.
McNutt Meter Box Co.

Mixers, Asphalt.
Austin Machinery Corporation.
Barber Asphalt Paving Co.
Cummer & Sons Co., The F. D.

Mixers, Concrete.
Austin Machinery Corporation.
Koehring Machine Company.
Lakewood Engineering Co.
T. L. Smith Co.

Mixers—Mortar.
C. H. & E. Mfg. Co.

Molds (Pipe & Culvert).
Heltzel Steel Form & Iron Co.

Motor Fire Apparatus.
Acme Motor Truck Co.
Diamond T Motor Car Co.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Motor Trucks.
Acme Motor Truck Co.
Duplex Truck Co.
Diamond T Motor Car Co.
Federal Motor Truck Co.
The Gramm-Bernstein Motor Truck Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Motor Truck Flushers, Sprinklers and Oilers.
Acme Motor Truck Co.
Austin Machinery Corporation.
Diamond T Motor Car Co.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co., The
The Gramm-Bernstein Motor Truck Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Municipal Castings.
Dee Co., Wm. E.
Madison Foundry.

Packing.
Pioneer Asphalt Co.

Paints (Asphalt).
Barber Asphalt Paving Co.
Barrett Co., The
Pioneer Asphalt Co.

Paving Blocks (Creosoted).
The Barrett Co.
Republic Creosoting Co.

Paving Brick.
Medal Paving Brick Co.
Metropolitan Paving Brick Co.
Murphysboro Paving Brick Co.
National Paving Brick Mfrs. Assn.
Springfield Paving Brick Co.

Paving Contractors.
Warren Bros Co.

Paving Joint Compound.
Barber Asphalt Paving Co.
The Barrett Co.
Pioneer Asphalt Co.

Paving Joint Filler.
Barber Asphalt Paving Co.
The Barrett Co.
Pioneer Asphalt Co.

Paving Machines.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Warren Bros. Co.

Paving Plants (Asphalt).
Austin Machinery Corporation.
Barber Asphalt Paving Co.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Good Roads Machinery Co., Inc.
Smith Co., T. L. The
Warren Bros. Co.

Pipe Cutters.
W. W. Strickler & Bro.

Pipe Dip and Coatings.
The Barrett Co.
Pioneer Asphalt Co.
The Texas Co.

Pipe Manufacturers.
American Cast Iron Pipe Co.
U. S. Cast Iron Pipe & Fdy. Co.

Pitch Filler.
The Barrett Co.
Warren Bros. Co.

Plows (Rooter and Wing).
Austin-Western Road Cach. Co.

Portable Paving Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Good Roads Machinery Co., Inc.
Warren Bros. Co.

Portable Stone Bins.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Pumps.
C. H. & E. Mfg. Co.
De Laval Steam Turbine Co.
Harris Air Pump Company.
Midwest Engine Co.
Smith Co., T. L., The

Reinforcing For Pavements.
American Steel and Wire Co.
Truscon Steel Co.

Road Building Material.
Barber Asphalt Paving Co.
Kentucky Rock Asphalt Co.
Sinclair Refining Company.
The Texas Co.

ing election to vote on $80,000 to pave and curb Branch, Main, Garden and Washington Sts.; ¾ miles long, 20 ft. wide, asph. brk. and concrete. Haines and Sherman, Temple Bldg., Camden, Engrs.

N. J., Paterson—City plans to pave several streets. About $450,000. H. J. Harder, City Engr.

N. J., Trenton—St. Hwy. Dept., Trenton, having plans prepared for improving 4 miles of road from Ancora to Atco. Abt. $400,000. T. J. Wasser, Trenton, Engr.

N. J., Trenton—City will soon ask bids for asph. paving, curbing, guttering and widening S. Montgomery St., State to Front Sts. Abt. $180,000. J. R. Fell, City Hall, Engr.

N. J., Trenton—Bd. of Freeholders, Mercer Co. having plans prepared for paving 4 miles Brunswick Pike, Clarksville to Middlesex Co. line, 20 ft. wide; sheet asph. on conc. base. Abt. $260,000. H. F. Harris, Engr. Court House.

N. Y., Rensselaer—Impvts. to streets here will be undertaken this spring and summer. One of the most important impvts. is that on 2nd St., Partition to John Sts. It is expected to improve abt. 500 ft. on the street to meet new grade and repair part of Broadway. At intersection of 3rd Ave., street will be raised 8 inches and city will be compelled to repave Bway. and lay conc. walks from Hudson brdg. approach as far north as Creek St.

N. C., Charlotte—Will call for bids in May to pave E. 4th, Bland, W. 8th and other streets; $150,000. A. H. Wearn, Commr. Pub. Wks. M. C. Hutchins, Engr.

N. C., Greenville—Council has decided to call for bids for approx. 4,000 yds. conc. paving to connect North St., with Laurens Rd., and to fill in unpaved link in Hampton Ave. City Engr. W. D. Neves instructed to obtain correct figures on amt. of grading, number of yds. of conc., etc., etc. Council also agreed on going ahead with paving North St. and Hampton Ave., two important thoroughfares. North St. stretch is abt. 1,700 ft. long; Hampton Ave. prop. is much smaller but important.

N. D., Bismarck—More than $4,000,000 will be spent for paving rds. on the National Parks Hwy. (Red Trail) during coming year. Most of the paving will be done in Washington and Idaho, where big bond issues have been voted, some in Montana and Minnesota and Wisconsin. Route will not be changed. There will, however, be an addn. in Idaho, to make three routes in crossing the Cascades.

Ohio, Hamilton—Petitions for paving 6 streets and 2 alleys received by council. All referred to Serv. Director and City Engr.

Ore, Hood River—Council has outlined plans for street impvts., which call for grading about 30 blocks residential streets and 2 miles cement curbs and gutters.

Pa., Greensburg—Orders have been given by local authorities for the partial paving of 24 streets in Town of Meadville this summer.

Pa., Harrisburg—Specfs. for paving sections of 31 city streets approved by council. Commr. W. H. Lynch, plans to call for bids in near future. Total est. cost of paving, $235,800.

Pa., New Castle—Petition approved and ord. drawn for consideration of council for paving of Laurel blvd., Highland Ave. to Neshannock blvd. Will be 20 ft. wide cartways on each side of 40 ft. grass plot in center, 10 ft. walks on each side. Street will be 20 ft. wider than Jefferson St., which is 80 ft. wide.

Pa., Reading—Definite announcement of streets to be paved made by Councilman Yeager in ord. introduced providing for impvt. and authorizing transfer of $370,000 from item provided in 1920 loan. to pay for the work. 37 squares will be improved, in northwest section of city. Work will start soon as bids can be received and contracts awarded.

S. C., York—York County will construct road to connect York with Cherokee Co. $100,000.

S. D., Yankton—Yankton County will spend about $245,000 for rd. and brdg. work this year. State will spend $200,000 additional. H. H. Corbin, Co. Hwy. Supt. Of the county funds, $125,000 will go for bridge work, $102,000 for hwy. impvt. and $18,000 for maint. of present roads.

Tenn., Athens—Will sell $90,000 to $120,000 bonds for paving sts. J. B. McCalla, Engr., Knoxville; R. P. Knight, Mayor.

Tenn., Bolivar—Hardeman Co. plans to construct 14.5 miles bitum. macadam rd. from Bolivar to McNairy Co. line. $350,000.

Tenn., Carthage—Smith County plans to construct 15-mile bitum. macadam rd. from Carthage to Wilson Co. line. $300,000. M. E. Bird, Co. Engr.

Tex., Big Spring—Bureau Public Roads, Washington, D. C., has approved application and proj. statement for proposed constr. of 32 miles Bankhead Hwy., Howard County. Surface 16-ft. gravel, $292,403.

Tex., Denton—Next paving planned is for N. Locust St. Est. cost abt. $30,000, and public square at cost of abt. $31,000.

Tex., Greenville—Chief Engr. U. S. Bureau Pub. Rds., Washington, D. C., has approved plans for F. A. P. 171, involving 11.1 miles 16-ft. bitum. macadam rd. on St. Hwy. No. 1, $406,831. O. P. McWhirter, Co. Judge; A. D. Duck, Engr.

Tex., Wichita Falls—Wichita Co. plans constr. of 17.6 miles 18-ft. conc. paved road on State Hwy. No. 5, $722,438. J. P. Jones, Co. Judge; J. M. Isbell, Co. Engr.

Wash., Bellingham—Road from Lynden to point near Sumas will be paved this year, about 9 miles; est. cost, $225,000.

Wash, Seattle—City plans to pave, curb and build water mains on 5 miles Rainier Ave., Mass. St. to 57th St., S., 17 ft. wide, involving 52,000 sq. yds. conc. paving, 19,038 ft. 8-in. water mains and 23,000 lin. ft. conc. curbing. Abt. $427,000. A. H. Dimock, City Engr.

Wash, Seattle—Highway Dept. will soon ask bids for bldg. and graveling abt. 15 miles Ocean Beach Hwy., beginning at Grays River and ending at Deep River. Abt. $200,000 appropriated for job.

Wis., Chippewa Falls—Plans being prepared for paving ½ mile Main St., from Greenville to Canal Sts., conc. or brick. Cost bet. $35,000 and $50,000. O. G. Holway, City Hall. Engr.

SEWERAGE AND SEWAGE TREATMENT.

Cal., Lodi—If approval of St. Bd. of Health can be secured, Bd. of Trustees will go ahead immediately with a plan for disposal of sewage of city. At cost of $120,000 it is proposed to build pipe line from septic tank to White Slough, 8 miles.

Cal., San Francisco—Appropriation of $790,808 to cover needed city impvts. requested by City Engr. M. M. O'Shaughnessy in communication to Bd. Pub. Wks. Largest item on list is $273,808 for extension of main line sewers in dists. covering abt. 5 sq. miles.

Fla., Miami—City plans to build abt. 25 miles of sewers in various streets. Abt. $170,000. C. W. Murray, City Engr.

Fla., St. Augustine—$425,000 bonds for sewer and water extensions will be issued. Eugene Masters, City Mgr.

Fla., West Palm Beach—Will construct 8 to 18 in. san. sewers; $100,000. Bids in 60 to 90 days. Plans expending $100,000 for storm draing. and paving. Carr & McFadden, Engrs.

Ill., Chicago—Initial step toward erection activated sludge sewage purification plant taken by Bd. of Trustees, San. Dist. of Chicago. Est. cost, $5,000,000. Plant will be located just outside northern city limits, near Devon Ave. Voucher for $269,995 authorized to purch. 179 acres land.

Ill., Chicago—Constr. of sewage disposal plant in Highland Park, costing about $100,000, will start at once. New plant will be located on the lake shore in Ravinia. Funds will be supplied by trustees of North Shore san. dist.

Ill., Villa Park—Village having plans prepared for constr. of sewers and sewage disp. plant. Work involves 12-54 in. sewers, 12-27 in. vitr. tile pipe, 30-54 in vitr. segmental blks. conc. settling tank and dosing chamber, conc. pump pit and pump, stone sprinkling filter beds, etc. Abt. $600,000. E. Hancock, 2047 Ogden Ave., Chicago, Ill., Cons. Engr.

Ind., Indianapolis—City plans to construct sewers in vicinity of Broad Ripple, from College Ave. to Fairview Pk. Abt. $290,000. F. C. Lingenfelter, 3025 Park Ave., Engr.

Ind., Richmond—City Council recommends constr. of S. 7th St. sewer. $55,000 appropriated for the impvt.

Mass., Boston—City plans to lay 1.25 miles 10-24 in. Akron drain pipe in S. Belgrade Ave. and Washington St., W. Roxbury; $30,000; Salt Crk. conduit, involving 165 ft. 7-ft. 6-in. rein. conc. pipe, Brighton, $27,000; two 7 ft., 9-in.x6 ft. 2-in.

BUYERS' GUIDE

Road Binder.
Barber Asphalt Paving Co.
The Barrett Co.
Pioneer Asphalt Co.
Sinclair Refining Company.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Road Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Road Graders.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Road Machinery.
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The
Barber Asphalt Paving Co.
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Lakewood Engineering Co.
Mayer, F.
Midwest Engine Co.
Warren Bros. Co.

Road Planer.
Austin-Western Road Machinery Co., The

Road Oil and Preservatives.
Barber Asphalt Paving Co.
The Barrett Co.
New Orleans Refining Co.
Standard Oil Co. (Indiana)
The Texas Co.

Road Rollers.
Austin-Western Road Machinery Co., The
Barber Asphalt Paving Co.
Good Roads Machinery Co., Inc.

Road Tampers.
Lakewood Engineering Co.

Rock Crushers.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Roofing Material.
Barber Asphalt Paving Co.
The Barrett Co.
Pioneer Asphalt Co.
The Texas Co.
Warren Bros. Co.

Sand Dryers.
Cummer & Son Co., The F. D.

Saw Rigs.
C. H. & E. Mfg. Co.

Sandstone.
Cleveland Stone Co.

Scarifiers.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Scrapers, Drag Line.
Pawling and Harnishchfeger.
Sauerman Bros.

Scrapers, Graders, Plows, Etc.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Scrapers, Power.
Sauerman Bros.

Sewage Treatment.
Direct Oxidation Process Corp.

Sewer Braces.
Kalamazoo Fdry. & Mach. Co.
Dee Co., Wm. E.
Madison Foundry Co.

Sewer Cleaning Machinery.
Stewart, W. H.

Sewer Forms.
Heltzel Steel Form & Iron Co.

Sewer Pipe.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.
Clay Products Association.

Sewer Rods.
Stewart, W. H.

Sidewalks (Stone).
Cleveland Stone Co.

Sluice Gates.
Coldwell-Wilcox Co.

Snow Removal Machinery.
Austin Machinery Corporation.
Good Roads Machinery Co., Inc.

Special Castings.
Crane Co.
Flower Valve Mfg. Co.
U. S. Cast Iron Pipe & Fdy. Co.

Sprinklers.
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The

Steel Joists, Studs and Sash.
Truscon Steel Co.

Steel Tapes.
Kolesch & Co.
Lufkin Rule Co., The

Stone Crushers.
Austin-Western Road Machinery Co., The

Stone Curbing.
Cleveland Stone Co.

Stone Elevators.
Austin-Western Road Machinery Co., The

Stone Flagging.
Cleveland Stone Co.

Stone Spreaders.
Austin-Western Road Machinery Co.
Burch Plow Works Co.

Stone Screens.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Street Cleaning Machinery (Horse Drawn).
Austin-Western Road Machinery Co.

Street Crossings.
Cleveland Stone Co.

Street Flushers (Horse Drawn).
Austin-Western Road Machinery Co.

Street Paving Material.
Barber Asphalt Paving Co.
The Texas Co.

Street Sprinklers (Horse Drawn).
Austin-Western Co., Ltd., The

Structural Steel.
Lewis-Hall Iron Works.

Surveyors' Instruments.
Kolesch & Co.
Lufkin Rule Co., The

Sweepers.
Austin Machinery Corporation.
Austin-Western Road Machinery Co.
Elgin Sales Corp.

Tamping Machines.
Pawling and Harnischfeger.

Tanks, Water Supply.
Mensch, L. J.

Tar and Pitch.
The Barrett Co.
Philip Carey Co., The

Tar Heaters.
Littleford Bros.

Tarvia.
The Barrett Co.

Testing Chemists.
Dow & Smith.
Walter H. Flood.
Howard, J. W.
Kirschbraun, Lester.
Van Trump, Isaac.

Traction Engines.
Austin-Western Road Machinery Co.

Traction Engines (Oil or Kerosene).
Austin-Western Road Mach. Co.

Tractors.
Austin Machinery Corporation.
Holt Mfg. Co., Inc.

Trailers.
Lee Loader and Body Co.

Trench Braces.
Kalamazoo Fdry & Mich. Co.

Trench Machinery.
Austin Machinery Corporation.
Kalamazoo Fdy. & Machine Co.
Pawling and Harnischfeger

Trinidad Lake Asphalt.
Barber Asphalt Paving Co.

Turbines, Steam.
De Laval Steam Turbine Co.

Valves.
Coldwell-Wilcox Co.
Flower Valve Mfg. Co.

Wall Coping.
Cannelton Sewer Pipe Co.

Warranite.
Warren Bros. Co.

Water Main Cleaning.
National Water Main Cleaning Co.

Water Pipe.
American Cast Iron Pipe Co.
Cast Iron Pipe Publicity Bureau

Waterproofing.
Barber Asphalt Paving Co.
Barrett Co., The
Pioneer Asphalt Co.
The Texas Co.
Truscon Steel Co.

Water Purification.
Direct Oxidation Process Corp.
Pennsylvania Salt Mfg. Co.

Water Softener.
The Refinite Co.

Water Works Supplies and Equipment.
American Cast Iron Pipe Co.
Cast Iron Pipe Publicity Bureau.
Coldwell-Wilcox Co.
Flower Valve Mfg. Co.
Mueller Mfg. Co.
Pennsylvania Salt Mfg. Co.

Wheeled Scrapers.
Austin-Western Road Machinery Co.

Wire Rope.
American Steel & Wire Co.

Windows (Steel).
Truscon Steel Co.

Wire-Cut Lug Brick.
Medal Paving Brick Co.
Metropolitan Paving Brick Co.
Murphysboro Paving Brick Co.
Springfield Paving Brick Co.

Wood Block (Creosoted).
Barrett Co., The
Republic Creosoting Co.

Wood Preservatives.
Barrett Co., The
Republic Creosoting Co.

rein. conc. twin channels, 500 ft. long, in Davenport Brook, Dorchester, $45,000; 1,200 ft. 2-ft. 9-in. rein. conc. outlet in Dana Ave., Hyde Pk., $20,000; 18x24 in. rein. conc. conduit, 500 ft. long, Chatham St. Boston, $14,000. J. S. Bowles, City Hall, Engr.

Mass., New Bedford—$200,000 bonds voted for sewerage in city.

Minn., Minneapolis—City will build tunnel sewer by day labor. Preliminary work beginning. $75,000 appropriated for 1921. Will take 3 years to complete. Through sandstone, 1 mile, 80 ft. below surf., walls of rein. conc., flr. of paving brick, 14 ft. high, 10½ ft. wide, $35,000 to be spent on machy. To build spur trk. 1,000 ft. long and trestle. Four dist. trunk sewers to be built later, will drain into tunnel. Carl Illstrup, City Sewer Engr., City Hall.

N. Y., Glen Cove—Proposed sewer extensions, costing $250,000 and providing an 'up-to-date and adequate sewer system, submitted to council by City Engr. Seaman. Extens. and additional equipt. contemplated provide for 3 pumping stations, one Imhoff tank and an outfall to the sound, in addition to various extensions.

Ohio, Bucyrus—Comm. of City Council is expected to recommend to council the purchase of sewer cleaning machine for city.

Ohio, Springfield—City Commrs. have retained Engr. Geo. G. Gascoigne, Cleveland, to prepare plans and est. of cost of constructing sewage disp. plant for city, cost of which will be betw. million and a half dollars. E. E. Parsons, City Mgr.

Okla., Oklahoma City—Immediate passage of Ord. to call election for purpose of voting on $2,000,000 bond issue for domestic sewage projects, urged by Pears, Greeley & Hansen, Cons. Engrs., Chicago, Ill. Recommendations, complete ests., detailed plans, etc., presented to City Comn. Engrs. state that complaints of State Health Dept. that river is polluted and a menace to health are well grounded and that work on disposal plant should begin immediately.

Tex., Dallas—City having plans prepared for laying 1½ mi. sewers in Pacific Ave., Olive St. to Trinity River, involving 24-84 in. rein. conc. and 15-24 in. vitr. clay tile pipe. Abt. $300,000. G. D. Fairtrace, City Engr.

Wyo., Cheyenne—$500,000 voted for san. and other storm sewers in various streets. J. A. Whiting, Cheyenne, Engr.

Wis., Milwaukee—Contracts aggregating $4,000,000 will be awarded by City Sewerage Comn. this summer. Contr. for boiler house will be let by June 1st, and plans for main disp. plant should be completed in April. Contracts should be let by latter part of June or first of July. Bids for water tube boilers will be opened on April 22. Boilers are to carry steam pressure of 230 lbs., superheated. Est. for boilers and automatic stokers abt. $350,000. Coal handling plant will be let as separate contract.

WATER SUPPLY AND PURIFICATION.

Que., Montreal—Water Bd. soon to receive bids for reinforcing main in eastern section of city, cost $1,159,000, northern section, abt. $1,433,000; also for additional main to connect part of northern division with low pressure system, $788,300.

B. C., Saanich—Municipal Council plans constr. of water works at est. cost of $150,000. By-law will be submitted in July. Hector Cowper, Clk.

Ont., Toronto—Works Comm. passed following ests. of Dept.: $75,600 to provide 12-in. duplicate feed main on Poplar Plains Rd.; $22,400 for 12-in. main into Earlscourt Dist., and $27,500 for 30-in. main on Duplex Ave.

Fla., Miami—Miami Water Co. will expend $150,000 to extend water mains; install 2½ miles pipe. Ordered 3 million gal. daily capy. pump.

Fla., St. Petersburg—Will call for bids in about 60 days for enlarging water works plant; constructing power plant on Lake Mirror; installing machy. and electrically driven pumps; increase wells from 7 to 9; lay additional water mains. $118,000 available.

Ga., Atlanta—$2,850,000 bonds voted for water works. This amt., together with unexpected appropriation of $450,000, makes a total of $3,300,000 avail. for impvts. Work includes additional 12 m. g. d. to filter plant, added filters to be of gravity type; 10,000,000-gal. clear water basin; 21,000,000 ft. to 48-in. force main from river station to filter plant, additional pumps at river sta., together with coal and ash-handling equipt.; new river intake, prelim. settling basins; additional distributing mains. Plans for filter plant and clear water basin are now being prepared and it is expected work will start immediately.

Ill., Herrin—Plans being prepared for extens. to present filter plant and new reservoir with capy. of 140,000,000 gals. at approx. cost of $115,000. City also expects to extend water mains at approx. cost of $200,000. A. C. Mallams & Co., Engrs.

Ill., Pana—Plans being prepared for reconstr. of 5,000,000-gal. reservoir. About $75,000. A. C. Stansfield, Pana, Engr.

Ill., Quincy—City having prelim. plans made for extending and improving water works system at about $200,000. W. R. Gellston, City Engr.

Iowa, Council Bluffs—Plans being prepared for rein. conc. reservoir 10,500,000-gal. capy. on 37th St., along Missouri River. About $100,000. J. H. Wayne Engrg. Co., 207 Pearl St., Engrs.

Ky., Harrodsburg—Pearse, Greeley & Hansen, Cons. Engrs. 39 W. Adams St., Chicago, Ill., authorized by city to prepare plans and specifs. and supervise constr. for improved water works comprising the following Remodeling and lengthening of existing stone masonry dam, 10 ft. high and 150 ft. long; installation of filter plant with capy. of 600,000 gals. per day; installation of low lift and high lift electrically driven pump. equipt.; laying approx. 1 mile 4-in. mains; minor repairs and addns. to municipal and elec. light plant, including, perhaps, installation of a 200 K. W. H. A. C. generator. Plans will be rushed in order that constr. work may be completed during present year and it is noped to awarded contract by June 15. Address the engrs. for information.

Md., Cumberland—$250,000 water and improvement bonds issued here.

Mo., Brookfield—$140,000 bonds voted to improve water works system. E. E. Harper, 3831 Park Ave., Kans. City, Mo., Cons. Engr.

N. J., Gloucester—Remington and Vosbury, engrs. submitted report to city council showing it will cost abt. $170,000 for contemplated improvements at water works. It is intention to construct new filter plant, $50,000; sink additional 8-in. well, $6,472; construct new bldgs., $36,000; install two high and two low serv. motor driven pumps, $12,250; new standpipe, $18,000; also foundations and other incidentals. It is planned to electrify plant.

N. J., Pitman—Boro. having plans prepared for water works and pumping stations, equipped with triplex heavy oil engines. Abt. $50,000. Remington & Vosbury, 6th & Market Sts., Camden, Engrs.

N. Y., Buffalo—Prelim. plans being prepared for filter plant. About $4,000,000. G. W. Fuller, 949 Bway., New York City, Cons. Engr.

N. Y., Watertown—Election being planned to vote on $500,000 bonds to develop water power on Black River at Delano Island. W. H. Cushman, Watertown, Cons. Hydr. Engr.

S. D., Redfield—$125,000 bonds voted to improve water works system. Work includes high water tank, pumps and extensions.

Va., Norfolk—Will purch. Norfolk Co. Water Company's pipe lines, etc.; will repair. Total cost $1,000,000. Chas. M. Ashburner, City Manager.

Wash., Marysville—Prelim. plans prepared for water works system. Bonds in amt. of $120,000 voted for prop. Stevens & Koon, Cons. Engrs.

Wash., Seattle—Water works and power plants est. to cost $200,000, planned by Miller Engrg. Co., 531 Burke Bldg., and construction work on several will start immediately. Included is new municipal hydro-elec. power plant for Bandon, Ore. which will develop 300 kilowatts and involve constr. of 16 miles pole lines. Cost $110,000. Another prop. calls for impvts. to water sys. at Ritzville, Wash., including elev. steel tank, new drop well & pump, extens. to services, etc. Work planned will involve expendt. of $50,000. At Coulee City, Wash., $24,000 bonds voted to purch. old water system and for impvts. to it planned by this engrg. firm. New water works sys. will be built at Creston, Wash., at cost of $20,350, if bond elec., May 4, is favorable. Plans completed for system. Two other towns near Seattle have also authorized Miller Engrg. Co. to plan water systems.

Wis., Milwaukee—Prelim. plans being prepared for pumping sta., brk., conc. and steel, rein. conc. flooring, conc. foundation, along bank of Milwaukee River. Abt. $1,500,000. G. F. Staal, City Engr. C. A. Cahill, 217 W. Water St., Cons. Engr.

INDEX TO ADVERTISEMENTS

Acme Motor Truck Co., Cadillac, Mich.....
Alvord, John W. & Charles B. Burdick, Chicago, Ill. 217
American Cast Iron Pipe Co., Birmingham, Ala. 215
American Steel & Wire Co., Chicago, Ill..... 8
American Telephone & Telegraph Co., New York, N. Y. 27
Artingsall, Wm., Chicago, Ill..... 217
Austin-Western Road Machinery Co., Chicago, Ill. 4
Austin Machinery Corporation, Chicago, Ill.

Barber, Asphalt Paving Co., Philadelphia, Pa. .....
Barrett Co., The, New York, N. Y..... 193
Brown Portable Conveying Machinery Co., Chicago, Ill. .....Inside Front Cover
Bitoslag Paving Co., New York, N. Y.....
Brossman, Chas., Indianapolis, Ind..... 217
Burch Plow Works Co., Crestline, Ohio.... 32
Burd & Giffels, Grand Rapids, Mich..... 217
Buyers' Guide 38, 40, 42

Cannelton Sewer Pipe Co., Cannelton, Ind... 10
C. H. & E. Manufacturing Co., Milwaukee, Wis. .....
Chicago Paving Laboratory, Chicago, Ill... 217
City Wastes Disposal Co., New York, N. Y.. 217
Cleveland Stone Co., The, Cleveland, Ohio.. 10
Coldwell-Wilcox Co., Newburgh, N. Y..... 218
Cummer & Son Co., The F. D., Cleveland, Ohio 32

Dee Clay Mfg. Co., W. E., Chicago, Ill..... 32
Dee, Wm. E., Chicago, Ill..... 10
De Laval Steam Turbine Co., Trenton, N. J.
Direct Oxidation Process Corp., Philadelphia, Pa. 218
Dow & Smith, New York, N. Y..... 217
Duplex Truck Co., Lansing, Mich.....
DuPont DeNemours & Co., E. I., Wilmington, Del. 2

Engineers and Contractors.....217, 218

Fargo Engineering Co., Jackson, Mich..... 217
Federal Motor Truck Co., Detroit, Mich..... 13
Flood, Walter H., Chicago, Ill..... 217
Flower Co., Detroit, Mich. 218

Gannet, Seelye & Fleming, Harrisburg, Pa. 211
Garford Motor Truck Co., Lima, Ohio.....
Granite Paving Block Mfrs. Assn. of the U. S., Inc., Boston, Mass..... 6

Heltzel Steel Form & Iron Co., Warren, Ohio 5
Hill & Ferguson, New York, N. Y..... 217
Holt Mfg. Co., Inc., The, Peoria, Ill..... 9
Howard, J. W., New York, N. Y..... 217
Hunt, Robert W. & Co., Chicago, Ill..... 217

Jones, Sam L., Cincinnati, Ohio..... 217
Jordan & Steele Mfg. Co., Inc., Charlotte, Mich. 29

Kalamazoo Foundry and Machine Co., Kalamazoo, Mich. 218
Kentucky Rock Asphalt Co., Louisville, Ky. 9
Kirchoffer, W. G., Madison, Wis..... 217
Kissel Motor Car Co., Hartford, Wis.....16, 17
Koehring Co., Milwaukee, Wis..... 23
Kolesch & Co., New York, N. Y..... 33

Lewis-Hall Motors Corp., Detroit, Mich....
Littleford Bros., Cincinnati, Ohio..... 8
Lufkin Rule Co., The, Saginaw, Mich..... 32

Macnaughton, David, Ft. Wayne, Ind..... 218
Madison Foundry Co., Cleveland, Ohio..... 10
Mayer, F., Chicago, Ill.....
Medal Paving Brick Co., Cleveland, Ohio.. 10
Metropolitan Paving Brick Co., Canton, O.
Midwest Engine Co., Indianapolis, Ind..... 6
Motor Truck Section.....11, 22
Mueller Mfg. Co., H., Decatur, Ill..... 209
Murphysboro Paving Brick Co., Murphysboro, Ill. 10

National Paving Brick Mfrs. Assn., Cleveland, Ohio .....
New Orleans Refining Co., New Orleans, La.

Olsen Testing Machine Co., Philadelphia, Pa. 10

Packard Motor Car Co., Detroit, Mich.....
Pawling & Harnischfeger Co., Milwaukee, Wis. 25
Pennsylvania Salt Mfg. Co., Philadelphia, Pa. 218
Pierce-Arrow Motor Car Co., Buffalo, N. Y.
Pioneer Asphalt Co., Lawrenceville, Ill..... 6
Portable Machinery Co., Inc., Passaic, N. J.
Portland Cement Association, Chicago, Ill.
Potter, Alexander, New York, N. Y..... 218

Republic Cresoting Co., Indianapolis, Ind... 10
Rosing Inc., Astrid S., Chicago, Ill..... 218

Sauerman Bros., Chicago, Ill..... 29
Shields, W. S., Chicago, Ill..... 218
Smith Co., The, T. L. Milwaukee, Wis.....Back Cover
Springfield Paving Brick Co., Springfield, Ill. 8
Standard Oil Co. (Indiana), Chicago, Ill.....Inside back cover
Stensrud, Herman, Marquette, Mich..... 218
Stewart, W. H., St. Louis, Mo..... 215
Strickler, W. W. & Bros., Columbus, Ohio.. 215
Sullivan, Long & Hagerty, Bessemer, Ala... 218

Texas Co., Asphalt Sales Dept., New York, N. Y. 7
Truscon Steel Co., Youngstown, Ohio..... 4

United States Cast Iron Pipe & Foundry Co., Burlington, N. J. 215
Uvalde Asphalt Paving Co., New York, N. Y. 10
Van Trump, Isaac, Chicago, Ill..... 218

Warren Brothers Co., Boston, Mass..... 1
Webster Mfg. Co., The, Chicago, Ill..... 213
Wells, James P., Rochester, N. Y..... 218

Compressed Stone Base for Warrenite-Bitulithic Pavement

This form of base has been thoroughly and successfully tested for many years under widely varying climatic and subsoil conditions, and has proven eminently satisfactory, including over 200 miles on the Columbia River Highway, Oregon, shown in illustration below.

COLUMBIA RIVER HIGHWAY, PORTLAND, OREGON
Warrenite-Bitulithic Surfacing over Old Macadam Sandy Road. Approach to the Columbia River Highway at Sandy River Bridge.

SERVICE AND QUALITY

the essential features in laying of Warrenite-Bitulithic. We furnish expert laboratory service with every pavement laid. The result is shown by the phenomenal growth of Warrenite-Bitulithic.

INSIST ON THE WARREN WAY

Illustrated Booklet on Compressed Stone Base furnished upon request, as well as other features of Warrenite-Bitulithic.

Warren Brothers Company

Executive Offices: 9 Cambridge St., Bowdoin Sq., BOSTON, MASS.

DISTRICT OFFICES:

New York, N. Y.	St. Louis, Mo.	San Francisco, Cal.	Vancouver, B. C.
Utica, N. Y.	Phoenix, Ariz.	Richmond, Va.	Toronto, Ont.
Portland, Ore.	Washington, D. C.	Memphis, Tenn.	Winnipeg, Man.
Chicago, Ill.	Minneapolis, Minn.	Los Angeles, Cal.	

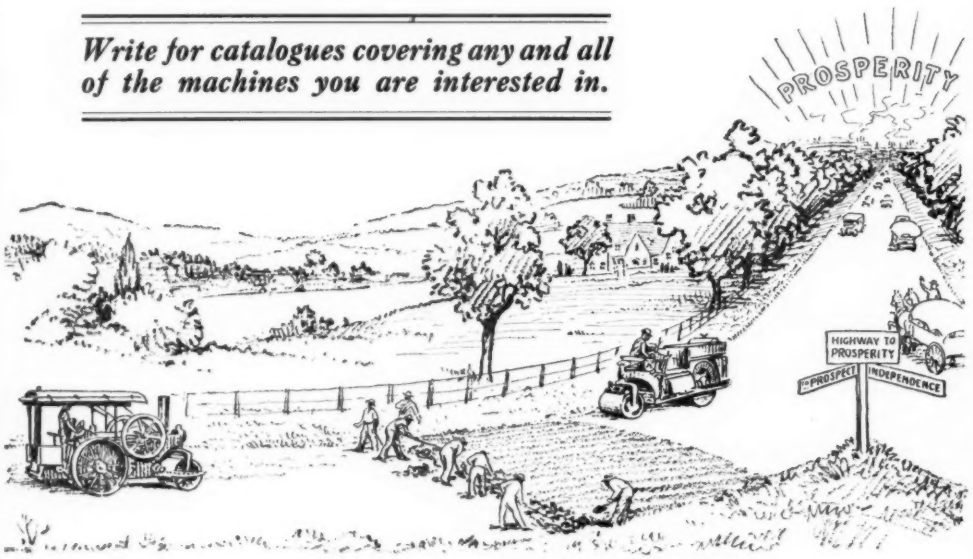
To the Alert Buyer

What does it mean to be able to buy all the machinery needed for the maintenance of your streets and roads from one company? It means just this: that the reputation and service of a nation-wide organization is back of each machine you own. It means that every machine is built right, built to cut costs. It means that you get "tried and true" products—no experiments here.

All these facts, and many more, make Austin-Western the line for municipalities to select and standardize upon. Thousands of counties and cities are now doing this and find that it pays.

In the Austin-Western line there are **quality-built** machines for every step in the building of a road—from crushing the rock to sweeping the finished pavement.

Write for catalogues covering any and all of the machines you are interested in.



The Austin-Western Road Machinery Co.

CHICAGO, ILLINOIS

Albany	Chicago	Jackson	New Orleans	Pittsburgh	Salt Lake City
Atlanta	Columbus	Kansas City	New York City	Portland	San Francisco
Billings	Dallas	Los Angeles	Oklahoma City	Richmond	Topeka
Boston	Denver	Nashville	Philadelphia	St. Paul	Wahoo

EXPORT DEPARTMENT
ALMACOA ALLIED MACHINERY COMPANY OF AMERICA ALMACOA